SOIL CONSERVATION

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FOREWORD

FUNCTIONS that considerably enlarge the scope of our activities have been assigned to the Service within the past few months. These new duties have laid on us heavy responsibilities that necessarily must modify our thinking and cause us to look closely to our administrative and technical organization. Yet now, as during the earlier life of the Service, our faith in the principle of a coordinated attack on land-use problems remains unshaken. I am convinced that we have effectively demonstrated the merit of this principle through our work during the past 5 years.

The rapidity with which soil-conservation districts are being formed is especially encouraging. The cooperative action of farmers and ranchers to create districts signifies that the American people are becoming increasingly aware of the urgent need for conservation of soil resources. I believe that every employee of the Service may be proud of his part in helping to bring about this new attitude. The complexity of the problems we are now facing in our enlarged program makes more essential than ever before the coordinated use of all the knowledge and avenues at our command.

In our efforts toward soil and water conservation, the biologist, no less than his fellow technicians in other fields, has won his spurs, and I am glad to see this issue of SOIL CONSERVATION dedicated to his work. The biologist seeks to turn wasted parts of farm and ranch to the benefit of wildlife by covering the wounds of erosion with healing vegetation. He has developed techniques of great value to farmers for stabilizing critically eroded areas. At the same time, his success in improving conditions for wildlife has been the means of pointing out to many people the importance of soil defense as the basis of all conservation.

These are accomplishments already credited to the biologists; but biologists as well as all other technicians, will need to exert themselves still more in the future. The development of land-utilization projects undoubtedly will call for a considerable expansion of our wildlife work. Much needs to be done to improve our present conservation practices and apply them most effectively in the solution of flood-control, water-facilities, drainage, farm-forestry, and drought problems.

The development of soil-conservation districts makes possible the coordination of individual, State, and Federal forces for the conservation of soil and its resources, of which wildlife must always be reckoned as one. If we continue to apply ourselves in the future as we have in the past, and if we maintain a clear, broad perspective of our objectives, I am confident that our part of the work to rehabilitate the Nation's wildlife will produce the results all of us desire.

H. H. BENNETT,
Chief.

WHAT IS A BIOLOGICALLY BALANCED FARM?

By Ernest G. Holt[1]

AMONG the several objectives of our wildlife management program upon which we have laid most stress is that calling for the establishment of a better biologic balance on the farms and ranches of the country. We have talked a great deal about this, and now many people are asking, "Just what is a biologic balance?"

I have anticipated such a question, and I have an answer: "There isn't any such thing!"

And now after that statement, it is necessary that I go much further and attempt to explain our reasons for using the term and to clarify its origin and meaning.

In the first place, we have used the term for want of a better one and because "the balance of nature" is talked about, loosely and widely, by that elusive individual, the man in the street.

If it is true that a biologic balance does not exist, it is equally true that Nature does dispose her various organisms in an elaborate system of checks and balances, one against another. Under natural conditions (barring cataclysms), it is very doubtful if any species has ever exterminated another. Despite all claims to the contrary, it is a matter of simple logic that it is impossible for predators to increase in numbers unless there has been a corresponding increase in the creatures they prey upon. When the augmented numbers of predators have brought the prey species back to lower population levels, then the predators also must fall off in numbers because of their diminishing food supply. Thus we have, not a balance in the sense of a static equilibrium, but such a balance as is represented by the simplest type of weighing apparatus. There is constant seesawing up and down, but always a tendency toward reduction of the arc of oscillation, so that even violent upswings in population do not allow a species to get entirely out of control.

But I have been describing that idyllic state of nature before the advent of so-called civilized man. I do not believe that nature ever reckoned on the civilized members of our genus. I willingly recognize primitive man as a natural factor in the environment; but no primitive man ever invaded virgin territory with steam shovels, ditching machines, gang plows, and swarms of cattle and sheep.

We are faced now with a situation that bears not the slightest resemblance to a normal order. Nature's checks and balances have been everywhere disturbed, often upset, and in some instances completely destroyed. And, if we are honest, we will admit that we have at times paid a heavy price for our carelessness, or ignorance, as the case may have been.

You may ask: "What, then, is to be done about it? We are here; we have subjugated the country; and, because we are civilized, we cannot live in harmony with nature as did the Indians."

I will grant the first two premises, but I will not concede entirely the third. My thesis is that we can live with nature far more harmoniously than we have been doing. But we must make comprises. We must reverse our old ideas that nature owes us everything, while we owe her nothing. The very least we can do is recognize and obey natural laws.

Probably our worst offense has been the upsetting of the "biologic balance." The consequences have been widespread and far reaching and affect not only the plants and animals, but the very soil whence they spring. Our reckless stripping away of the vegetative

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cover of the soil has driven out the animals and invited in the forces of erosion, which are now exacting the terrific toll of 300,000 acres of land annually. This is equivalent to dumping into the ocean each year 1,875 farms of 160 acres each. It means that our failure to compromise with nature is each year depriving 1,875 families of their means of livelihood. If you think that I am straying from my subject, let me remind you that these farms are going down the river because we are not maintaining a reasonable biologic balance on them.

You may at once object that I am unwarrantedly dramatic, that total destruction of the land is an extreme result not likely to follow our thoughtless tampering with nature's balance. But have you considered that in the few generations of our national existence such tampering has already laid waste a hundred million acres, has stripped another hundred million acres of one-fourth to three-fourths of its topsoil, and has opened the way for active erosion on still a third hundred million acres?

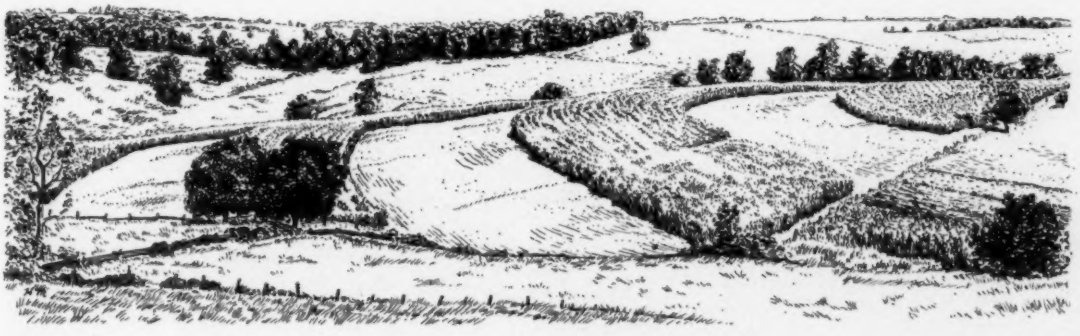
Biology has to do with the whole flora and fauna—the biota. But how can you consider a plant or an animal apart from its environment? And is not soil just as important to a plant or an animal as air or water? In fact the relation is reciprocal. Plants, animals, and soils are so bound up in a highly intricate complex of interrelations that, in some degree at least, anything that affects one affects all the components of a given community. Upsetting the biologic balance has the more immediate effect on plants and animals, but soils eventually and inevitably are injured or destroyed. I have cited the effect upon soils because we have been able to measure it; after plants and animals have gone it is extremely difficult to arrive at a quantitative estimate of the original biota.

Notwithstanding these interrelations, which are sometimes obvious to him who would see, it is usually difficult to convince the human creature that he should shoulder the blame when he tips the scales on the wrong side and something begins to happen that he has not bargained for.

For example, I have seen men who held that pocket gophers were responsible for the destruction of high mountain meadows which the gophers themselves had helped to build, and which they, through their working of the soil, had maintained in a high degree of productivity, from the recession of the glaciers until the invasion of domestic livestock. When the cattle and sheep had eaten the vegetation from these high mountain meadows and laid bare the soil, grazing pressure was not reduced to give the meadows a chance to recuperate. Erosion finished the job the livestock started, and the gophers took the consequences.

On the western range I have heard bitter complaint against the ravages of jack rabbits. Again let us look beneath the surface and see what we may find. Our first observation is that more cattle and sheep are being run than the range can safely support. The original grasses have almost disappeared, and their places have been taken by range weeds, mostly of the brushy type. With the change in cover type, and the destruction of natural rabbit predators which has been going on at the same time, the jack rabbits have increased and are, in fact, taking a heavy toll of what little grass is left. Now, on these western ranges, livestock numbers must be reduced to safe carrying capacity, so that the range may build back to the climax grasses.

Years ago I investigated a damage complaint which came from a small ranch in Arizona. Upon arrival I found a veritable oasis in the desert. The rancher had cleared a few acres of creosote bush, miles from his nearest neighbor, and by irrigation from a deep well was making the desert literally to blossom as a rose. Peaches, plums, grapes—fruits never before seen in those parts—were bearing heavily. Then the inevitable happened. The birds of the desert came in to the feast and the fruit was no more. Quail that never in their lives had tasted a peach came in flocks and



literally cleaned the trees. Thrashers, mockingbirds, verdins, all took their toll.

I cite this case as just another example of lack of forethought, as just another score against our common human failure to give heed to nature's laws. In an adjacent district fruit was being grown and harvested successfully, and the ranchers suffered so little damage from birds that they thought nothing of it. But there the ranches were in a block of considerable size, not just a patch of a few acres surrounded by an enormous expanse of desert; there was some semblance of balance between the fruit crop and the bird crop.

The robin and the cherry crop provide another case in point. Everyone knows that robins are capable of wreaking havoc in an orchard of ripening cherries. Not all of us, however, stop to think that often the robins more than earn the cherries they eat, through their destruction of insect pests; or that they apparently prefer wild cherries to tame. Would it not be the part of wisdom to let wild cherries grow up along our fences instead of so zealously putting them to the ax?

In the Midwest, high productivity and intensive agriculture have placed such a premium on every available square foot of soil that farmers have been moved to do things that we now know were ill-advised.

The old rail fence has been replaced by barbed wire to allow an additional "land" to be given to the plow, and to be kept scrupulously clean of vegetation lest the farmer be considered untidy. With the rail fence and the thickets that filled its angles have gone the quail and other birds that delighted the eye and ear of the farmer and helped to keep down the chinch bugs, potato beetles, and clover weevils that now overrun his fields.

The woodlot has been cleared from the hill to make more pasture. With the trees have gone the grouse and squirrels. The thin sod, trampled by too many cloven hoofs, has not been able to carry on the good work of the woods. Gullies begin to gnaw into the steep slopes—while the farmer hauls his fuel from town.

And the old swimming hole—surely we shall find that unchanged. But the hope is a vain one. That strip of trees and shrubs along the creek shaded too much potential grass for the dairy herd. With the vegetation went the only protection the creek banks had against the scouring freshets that have increased in violence as the uplands were denuded in their turn. The swimming hole, where the farmer himself used to catch trout whenever he could find the water free of his own boys, has given place to a chasm which stretches its jaws wide for the barn.

This also may appear melodramatic; but I have deliberately chosen my illustration, and I can take you, not to one farm like this, but to dozens. And every one of them is out of balance biologically.

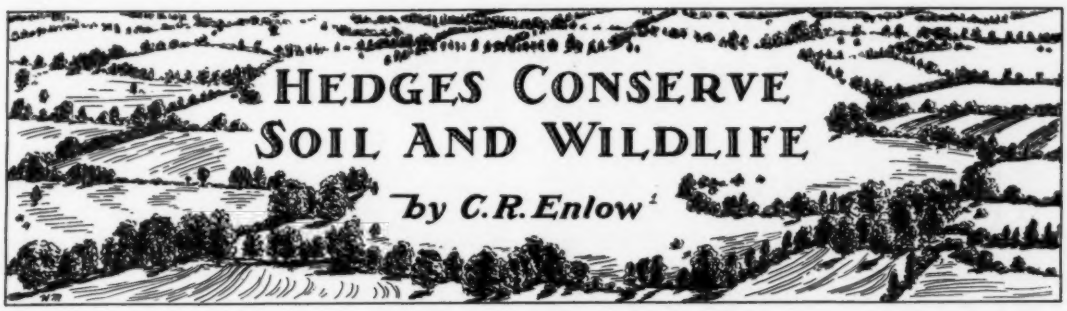
Just what do I mean by a biologically balanced farm? Not, as you may think, one that has reverted to its pristine condition. While you and I are just as much dependent upon the soil of that farm as are its old maples and oaks, our main dependence is expressed in terms of products of cultivation. Agriculture is essential to our existence, and the pursuit of agriculture involves a profound disturbance of natural conditions. It is unthinkable, therefore, that we could restore a semblance of the original balance.

Nor is it necessary. It is true that the production of agricultural crops demands the removal of a tremendous proportion of the native vegetation from the soil. But it demands neither the destruction of all native vegetation nor the exposure of all soil to the elements. On the other hand, the safety of our whole agricultural structure demands that a reasonable balance be maintained between soils, animals, and plants, both wild and cultivated.

I conceive a biologic balance as having been attained when destructive influences (admittedly necessary in agriculture) are compensated for by constructive or protective measures. In other words, when we so manage a farm as to conserve its natural resources of soil, water, vegetation, and wildlife, while producing a safe and reasonable volume of agricultural products, we are well on the way to this balance.

This does not mean turning the farm back to trees or grass. It does mean contour cultivation, strip cropping, and sound crop rotations to protect land bared by cultivation; it means safe grazing pressure on pastures; it means the maintenance of permanent vegetation on all critically erodible areas. Above all it means that we must make a careful study of the conditions as we find them, discriminate between cause and effect, and act in harmony with nature instead of at cross purposes.

When we have restored enough vegetation to protect our eroding soils, and in the process have given due thought to wildlife food and cover, the birds and small mammals will quickly respond. They will do their part by preying on the insect enemies of the plants, which in turn will check the run-off of rainfall, and allow it to soak into the ground to maintain the water table, to ensure perennial springs, to lessen flood crests in streams. Moreover, by careful husbandry, the fertility of the land we till may be built up so that we may obtain the same yields from fewer acres, and thus conserve our energy as well.



Hedges and tree rows used for field boundaries near Ailes, France, provide safe travel lanes by which game birds can move freely from one place to another. (Drawing made from photograph.)

IT SEEMS logical, in connection with planning erosion control, to make comparisons between our practically new agriculture and the agriculture of Europe where farming has been under way for many generations. While such comparisons may be subject to criticism because of differences in type of farming, soils, total precipitation, intensity of rainfall, etc., certain individual European practices are comparable, to some extent, with those used in some sections of this country. Probably the outstanding difference is that in Europe there is universal recognition of the need of crop rotation for the maintenance of soil and for the permanence of agriculture. The use of grass and legumes in the rotation, the importance of proper land use, careful productive management of pastures, and the use of hedges for field boundaries are given particular attention in Europe. It is in connection with the latter practice—the use of hedges—that this article is written. The advantages of hedges for erosion control and the preservation of wildlife, particularly birds, are immediately apparent to the observer studying European agricultural methods.

An opportunity was afforded me in 1937, in connection with the meeting of the International Grassland Congress, to spend 3 weeks inspecting the principal areas of grassland interest in England, Wales, and Scotland. Following this tour, which was made by some four hundred agrostologists from all over the world, I spent 3 weeks in an individual tour of French farms with the idea of observing at first hand the farming practices and erosion-control methods employed in that country. Particular attention was given to crop rotation, field arrangement, pasture practices, and orchard cover crops. The use of hedges had not been given previous thought and, consequently, their prevalence was all the more impressive.

The first impression of hedges in England, where the trip started, was mainly one of annoyance. The hedges were high enough effectively to block a view of the fields from highways, and constant alertness was required to take advantage of the breaks in the hedges and the high points in the terrain to get a general impression of the agriculture.

Throughout Great Britain, where the agriculture is so predominantly grass management, the value of hedges for erosion control was not particularly apparent. In France, however, I observed innumerable hedges planted across the slope with the soil above the hedge 3 or 4 feet higher than the level of the soil below the hedge; there were also instances where the difference was as much as 5 feet. Due to the old system in France of dividing the farms so that each heir might have a separate parcel, the fields on the average are quite small. In many localities every field is bordered by a hedge. On sloping land this provides effective erosion control, as the hedges break the length of the slope. It is quite apparent, however, that the practice was not initiated with this idea in mind and that much more effective control could have been obtained had the hedges been planted on the contour. In some sections of northeastern France, I saw not only contour hedges but contour fences, contour cultivation, and contour strip cropping as well.

For the protection of small birds, the use of hedges seems ideal. In both Great Britain and France many coveys of partridges, resembling our quail, were in evidence. Invariably they were making headquarters in the hedges. I gained the impression that much heavier populations of birds were present in both Great Britain and France than in the United States, and there can be little doubt that the excellent cover afforded by the hedges is responsible for the larger numbers.

Hedges in England are usually very different from

(Continued on p. 223)

[1] Head, section of agronomy and range management, Soil Conservation Service, Washington, D. C.

LEGUMES FOR EROSION CONTROL AND WILDLIFE

By Edward H. Graham[1]

PLANTING programs for the improvement of wildlife habitats have laid heavy emphasis upon the use of woody plants. Herbaceous species, however, are more valuable than their limited use would indicate, and among them the grasses and legumes are outstanding groups. They propagate readily by direct seeding, mature in a short time, provide important food and ground nesting cover for wildlife, and rapidly produce a protective blanket of vegetation useful in controlling erosion.

Many leguminous plants are proving so helpful to the soil conservationist and wildlife manager that the Service is giving careful consideration to this plant family. Within the United States there is a native leguminous flora of about 2,000 species. Among our crops there are nearly 50 legumes of commercial importance. Many of our native Leguminosae appear as pioneer plants on denuded areas, or occur most abundantly where soil is poor and grass is thin. Consequently they are exceptionally useful in revegetating eroded sites. Their function of enriching the soil through the fixation of atmospheric nitrogen by means of root nodule bacteria gives them an added value for soil conservation.

While the American farmer uses comparatively few legumes as food crops, a single native American game bird, the bobwhite, includes 88 different kinds of legumes in its normal diet. In the Southeastern States, so important are they as food for bobwhite that the number of native leguminous plants growing over the vast coastal "flat woods," areas little frequented and consequently not shot out by man, can be relied upon as an index to the quail population of the region. The bobwhite is not the only bird with a liking for these plants. The Gambel's quail is known to eat 30 species of legumes. The Arizona scaled quail utilizes a couple of dozen different kinds. The eastern mourning dove, mallard, California quail, and ring-necked pheasant eat the leaves and seeds of numerous species. The high protein content of leguminous seeds makes them particularly valuable as staple winter foods. Good use can be made of leguminous plants if they are seeded to provide food adjacent to adequate woody cover. In some places light disking of the ground is all that is necessary to ensure the volunteer appearance of partridge peas, tick trefoils, and other native legumes.

A review of literature now in progress, and an examination of stomach records in the Bureau of Biological Survey, reveal, to date, that 244 species of leguminous plants are known to be used as food by 231 animals, of which 95 are mammals and 136 are birds. The following tables indicate the legumes most used by wildlife for food, and the animals which use them:

Legumes most used by wildlife

GENERA

Legumes	Number of wildlife species using legumes for food		
	Birds and mammals	Birds	Mammals
Trifolium (clovers)	100	79	21
Medicago (alfalfa, bur clovers)	56	41	15
Lupinus (lupines)	36	23	13
Melilotus (sweetclovers)	31	24	7
Vicia (vetches)	26	22	4
Cassia (sennas)	22	21	1
Pisum (peas)	20	17	3
Robinia (locusts)	18	9	9
Prosopis (mesquites)	17	5	12
Phaseolus (beans)	16	9	7
Astragalus (milk vetches)	15	6	9
Lotus (birdsfoot trefoils)	14	9	5
Desmodium (tick trefoils)	13	10	3
Lespedeza (bush clovers)	12	9	3
Chamaecrista (partridge peas)	10	9	1

SPECIES

Medicago sativa (alfalfa)	38	25	13
Trifolium repens (white clover)	28	21	7
Medicago hispida (California bur clover)	22	18	4
Trifolium pratense (red clover)	18	11	7
Pisum sativum (garden pea)	17	16	1
Prosopis chilensis (mesquite)	17	5	12
Melilotus alba (white sweetclover)	13	8	5
Robinia pseudoacacia (black locust)	11	5	6
Arachis hypogaea (peanut)	9	5	4
Melilotus indica (sour clover)	8	7	1
Sesbania macrocarpa (sesbania)	7	7	0
Lespedeza striata (common lespedeza)	7	6	1

Wildlife species which use legumes most

Birds	Number of legume species eaten	Mammals	Number of legume species eaten
Bobwhite	88	California mule deer	29
California quail	31	Virginia deer	18
Gambel's quail	30	Rocky mountain mule deer	11
Eastern turkey	25	Rocky Mountain bighorn	11
Arizona scaled quail	23	California jack rabbit	8
Eastern mourning dove	19	Eastern cottontail	7
Ring-necked pheasant	17	Antelope jack rabbit	6
Common mallard	13	Merriam kangaroo rat	6
Greater prairie chicken	9	Sonora white-tailed deer	5
Northern horned lark	9	Virginia opossum	5

[1] Biologist, section of wildlife management, Soil Conservation Service, Washington, D. C.

The widely consumed clovers and alfalfa are forage crops perhaps as much eaten by wildlife for their succulent vegetation as for their seeds. The lupines are primarily wild plants, while the sweet clovers occur in many places more as naturalized weeds than as crops. Many of the legumes belonging to the other genera listed are native, uncultivated species of interest to the wildlife manager because their maintenance does not require the attention demanded by cultivated plants. Except for Robinia, Prosopis, and Astragalus, the legumes are shown to be utilized more by birds than by mammals. Gallinaceous birds make the greatest use of legumes, and all the birds listed except the mourning dove, mallard, and lark belong to the Galliformes. Among mammals the ungulates apparently use legumes most, for we find 4 deer and a sheep in the list of 10. Certain woody legumes such as mesquite and black locust are used by wildlife, but the woody species are few in number, as 98 percent of the legumes that grow in the United States are herbaceous plants. Although leguminous species generally do not seem to be utilized by wildlife as extensively as certain nonleguminous woody plants such as the oaks, blackberries, elderberries, pines, and sumacs, nevertheless the widespread utilization of clovers, alfalfa, lupines, vetches, and many other legumes proves them to be of outstanding importance to the wildlife manager.

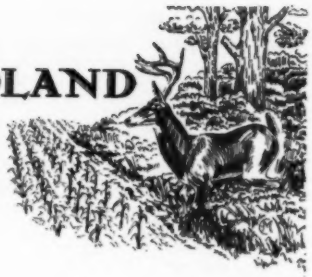
Among the leguminous plants most used by wildlife are a number of crops which are notably erosion-resistant, especially when they are sown with grasses or used in pasture mixtures. Among them is alfalfa, which is recognized as one of the principal foods of the sage hen, Columbian sharp-tailed grouse, and eastern bobwhite. The clovers vie with alfalfa as wildlife food. White clover is a preferred food of the prairie sharp-tailed grouse, is a favorite of the muskrat when available, and is consumed by ring-necked pheasant and sage hen. Red clover is nearly as promiscuously used, and is so much preferred by the woodchuck that, in the East, red-clover fields and woodchucks seem almost inseparable. California bur clover is another crop legume widely utilized by birds, especially by California quail; it has even been recorded from the stomachs of waterfowl, specifically baldpate, cinnamon teal, and green-winged teal. Garden peas are highly prized by wild animals as food, and among the two dozen animals known to eat them are the band-tailed pigeon, ring-necked pheasant, bobwhite, rose-breasted grosbeak, red-headed woodpecker, sage hen, and Baltimore oriole.

During the past planting season, the Service used for erosion-control purposes approximately a million pounds of legume seed representing more than a dozen different species, exclusive of less common kinds grown in our nurseries for transplanting. Among nursery-grown plants, the black locust has led not only all other legumes but all other plant species. The Service and its cooperators have planted approximately 100 million locust trees in the past 5 years. Next year about 15 million will be used—only half the yearly average previously planted. The reduced proportion of locust to other trees will afford a better selection of species to meet the ecological requirements of the various sites on which they are to be used. A leguminous vine of great value for erosion control in the Southeast is kudzu (*Pueraria thunbergiana*). Twelve million vines will be transplanted to raw gullies and eroding areas next year.

Soil conservation measures include the use of legumes in crop rotations, strip cropping, pasture improvement, gully and gall-spot revegetation, and the planting of terrace outlet channel margins and field borders. A field border plant that is gaining great favor in the Southeastern States is the introduced perennial *Lespedeza sericea* which controls erosion on unproductive field borders and at the same time furnishes ground nesting cover for wildlife, and turn rows for teams working the field. It is likewise used on the berms of terrace outlet channels where it prevents the Bermuda grass planted on the outlet bottom from spreading to adjacent cultivated areas. It also has successfully stabilized seriously gullied areas.

Native lespedezas likewise show promise of combined usefulness in soil and wildlife conservation; all of them possess the advantage of being perennial. Among them *Lespedeza virginica* would seem a promising plant to do throughout the East what *L. sericea* has done so successfully in the South. It is much like *L. sericea* in habit, grows well on dry, poor soil, and is a good soil improver. Its wildlife record includes use by bobwhite and wild turkey. Other native lespedezas, which vary in habit from prostrate or low species to tall coarse forms, are known to be utilized by wildlife for food, and show inherent soil-preserving tendencies. Last year the Service used 400,000 pounds of lespedeza seed, including native and introduced, annual and perennial species, and produced in the nursery nearly 2 million lespedeza transplants of half a dozen different kinds. Many other legumes promise to contribute to the control of erosion and the benefit of wildlife. On a wide variety of soils and under varying climatic conditions the Soil Conservation Service nurseries are propagating and carefully observing numerous native as well as introduced species to determine their potential value in our program.

IMPROVING FARM WOODLAND FOR WILDLIFE



by Frank C. Edminster

WOODLANDS often occupy the most erodible lands on the farm—the steep slopes, rough areas, ravines, and streambanks—and consequently the way in which they are treated is a matter of considerable importance in soil conservation. If properly managed, the cover of woody vegetation holds the soil in place; but once the woodland is abused it deteriorates and the soil begins to wash away, often destroying other fields as well as the land from which it came. Optimum yield of both the plant and animal products of the woodland depends upon proper management and thereby is the economic justification for this essential erosion-control cover in the farmer's land-use plan.

Any successful plan of management must recognize the ecological nature of a woodland. It consists of a community of organisms of many species of both plants and animals, bound together and surviving by virtue of an intricate network of mutual relationships, many of them as yet little understood.

The animals inhabiting woodlands continually benefit the woodland itself, and game and fur may be harvested as an annual crop while the owner awaits the development of timber. Practically all silvicultural operations affect these animals. It is therefore important that woodland management include practices for the maintenance of wildlife requirements—this in order that a maximum combined crop of woods, wildlife, and other products be provided and the continued healthful survival of the woodland be assured. This requires some knowledge of the particular features which make certain woodlands favorable habitats for wildlife.

A woodland suitable for wildlife must be properly maintained from the standpoints of soil conservation and silviculture. Protection from fire is essential in most woodland types. Exclusion of livestock is vital to erosion control on steep land, and to adequate plant reproduction on almost any land. Since good forestry requires that all trees (except den trees) should be harvested for their wood products upon reaching their greatest growth of sound wood, the woodland will be an uneven-aged stand, predominantly second growth and immature. This is consistent with good ecology, which requires that any community, to continue to thrive, must be composed of individuals of all ages.

A mixed woods is most favorable for wildlife. A woodland composed of two or more types is superior to one of a single type, and within each type a variety of species generally is desirable. Single-species stands are more subject to insect and disease hazards. At best they furnish but a restricted food supply and a single type of cover to wildlife—far from a balanced diet or satisfactory protection. It is well to maintain a scattering of all species indigenous to the type, if not as crop trees, at least as fillers and for their wildlife values.

The size and arrangement of the types within the woodland also are important. Wildlife is a product of edges—the borders between vegetation types. The first hundred feet into a type is highly productive of wildlife; the second hundred feet is still productive, but less than the first; the third less than the second, and so on. In the Northeast, as a general rule, the width of a single type of woodland should not exceed 600 feet so that no point will be more than 300 feet from an edge.

Another cardinal principle in wildlife management is that all cover and food types needed by a species must exist within the cruising radius of the species. If an animal is so constituted that it will not travel over an area greater in radius than a quarter of a mile, then all its requirements must be provided within that space; otherwise, it cannot occupy the area at all. Thus it is important that all needed types be so interspersed that they are conveniently located with respect to one another.

Woodland management for soil conservation and the production of wood products and wildlife is largely a matter of controlling ecological succession.

[1] Regional biologist, Soil Conservation Service, Upper Darby, Pa.

By various cultural practices, the development of the plant association is directed toward what is conceived to be the most desirable composition, quality, density, and arrangement of the stand. In managing a woodland for multiple use, a course of moderation must be pursued. The highest potential development of any one product occasionally must be foregone in favor of others. The plan of management should include principles and practices that will assure a reasonable crop of wildlife along with the wood products.

Every woodland is a separate problem, and must receive individual treatment. From the standpoint of wildlife management, the first step is to analyze the existing situation in terms of food and shelter. The stand then should be handled so that these factors are improved and maintained at the highest level consistent with other objectives.

In stands deficient in shelter, these practices may be employed: (1) Liberation of suppressed conifers and other shelter-producing species; (2) interplanting of conifers in poorly stocked stands, adjacent to food-producing coverts, where protection from grazing is not likely to result in adequate natural seeding; (3) construction of brush piles from cuttings, adjacent to food units; (4) hastening development of potential den trees by girdling.

In stands deficient in food, the following will be beneficial: (1) Liberation of food-producing trees and shrubs, especially adjacent to existing shelter units—a practice which is most effective near the border of the woodland; (2) selective cutting to create small openings adjacent to shelter to admit sunlight to the forest floor and induce germination and fruiting of many food species—a good system of woods roads is helpful in making openings; (3) planting woodland margins to borders of food-producing woody vegetation.

In all cases, emphasis should be placed on proper arrangement of food and shelter. The two should exist in adjacent units and with as much interspersion as possible.

The fact that woodland edges provide the best wildlife habitat should be kept in mind. Emphasis should be given those parts of woodlands within 200 feet of openings. In arranging the cutting blocks in a sizeable woodland, it is often desirable to treat the outer 100- to 200-foot zone as a separate block, with cutting particularly aimed at wildlife habitat improvement. In extensive areas of uniform type, the break-up may be accomplished through differential cutting and the creation of different age-class combinations. Harvesting of timber may then be accomplished by a long rotation of light cuttings without endangering the soil.

The woodland border normally is an edge between two types, the woodland itself and some open-field type. The amount of desirable "edge" may be doubled by the introduction of a third type—the shrub association—between these two. Low-growing woody plants which furnish wildlife food—fruits, nuts, or seeds—should be used. Such a strip occupies a zone that is often unproductive of field crops and subject to accelerated erosion. Utilization of this strip for border planting is good silviculture in that it affords protection to the woodland from drying and damaging winds and serves to train up the outermost woodland trees.

The width of such a planting may depend on the extent of the unproductive field border, on the land use in the adjacent field, and on the interest of the owner in improving his woodland. Usually from 20 to 30 feet may be devoted to this purpose. Species should be selected and planted to produce a banked growth, the lowest next to the open field and the highest on the woodland side. The low plants may be herbaceous perennials, low shrubs, or vines, and the succeeding rows progressively higher species, with tall shrubs or small trees next to the woodland trees. This sloping-top form of a woodland border serves to direct air currents over the woodland, prevents the formation of another unproductive field border, and provides an abundance of sunlight, so necessary for good seed production, to all the plants.

In woodlands from which the coniferous element has been eliminated, there may be no reasonable probability of natural conifer reproduction. In such instances, where wildlife shelter is markedly deficient and the crown canopy of hardwoods is relatively sparse, interplantings of conifers may be made in clumps under the crown openings. The standard plantation spacing may be followed, and usually only shade-tolerant species should be used. Where the crown openings are fairly large and understory competition is not too severe, less shade-tolerant species may be included.

The composition, quality, and density of the stand may be modified by selective cutting. In these operations, consideration should be given to the needs of wildlife as determined by the initial examination with respect to food and shelter supplies. Each piece of woodland must be studied separately in order to decide which species are to

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be favored for the benefit of wildlife. This depends on the kinds of wildlife being encouraged. Usually it is desired to manage more than a single species, and the requirements of all must be blended into a plan. A typical example from the Northeast is described to point out details of woodland management for erosion control and wildlife.

THE wildlife species particularly desired in a certain woodland are ruffed grouse, gray squirrel, and cottontail rabbit, in addition to the song and insectivorous birds. Considering shelter first we find that among the trees present the hemlock is most desirable for the ruffed grouse. The gray squirrel depends primarily upon hollow trees for shelter, hence much emphasis will be given to developing hardwood den trees. Rabbits require marginal thickets in the understory and to supply this need raspberry, arrowwood, hazelnut, yew, and other thicket-forming species will be favored.

Food requirements are considered next. For the grouse several trees furnish buds, mast, or fruit. In this woodland the most important are yellow birch, hop hornbeam, beech, white oak, blue beech, and black cherry. In the understory we find witchhazel, mapleleaf virburnum, and grape. For the gray squirrel, the emphasis is to be primarily on mast producers—in this instance, beech, white and red oaks, and hazelnut. Flowering dogwood also is a valuable squirrel food. The food requirements of the rabbit are not so well known. Raspberry and a number of other shrubs already selected as shelter species, as well as many herbaceous plants, are eaten by rabbits. No additional woody species, therefore, will be selected for this purpose.

Requirements of small birds are largely met by plants already named. However, bayberry and spicebush are added to the list for the food they furnish. Altogether, nine trees and nine shrubs will be favored for the benefit of wildlife in this woodland. Hollow trees for dens will be preserved or developed.

It must be understood that these 18 woody species are not the only valuable plants in the woodland community. Rather, they constitute the group which may be developed most effectively to improve wildlife conditions. Many other plants, both woody and herbaceous, will play their part in a balanced woodland ecology. The example cited is only the one instance, but the principles of selecting wildlife plants are essentially the same in any woodland.

After it is decided which species are to be favored, cutting is directed toward their encouragement. This sometimes is accomplished by the release of suppressed individuals through removing the competing plants. Some species may be increased by making small openings in the woodland to induce germination of seed on the forest floor. Occasionally planting is necessary to reestablish conifers depleted by lumbering.

Where den inhabiting animals are wanted, hollow trees, or "wolf" trees in the process of becoming hollow, should be left at the minimum rate of two per acre. Girdling sometimes may be used to speed up development of hollows and eliminate dominating foliage.

Improvement of quality in the stand is a matter of selective cutting of individual specimens rather than of species. In woodland management for timber this is done by removing the defective trees, thereby providing space for other trees of better form. Wildlife plants likewise may sometimes be inferior because of unhealthy condition, in which case they should be removed. But many times the tree valuable to wildlife is retarded for want of light. In such an instance the remedy is to remove enough of the competing stems to provide light for the retarded tree, with due consideration, of course, to the value of the competing trees. Other factors being equal, individuals of seedling origin should be favored over coppice or sucker growth.

Plants furnishing browse become unavailable if they grow too high. By cutting, many species may be made to regain this value through sprout growth.

A crown cover of at least 60 percent—that is, three-fifths of the ground shaded by tree foliage—should be maintained in all cases. Even if inferior in quality, a 60-percent crown should be maintained to provide adequate erosion control and to serve as a nurse crop for more valuable species. Living trees should be cut only to release more desirable individuals, to improve seeding and germination conditions, to decrease overstocking, or to remove plants that are seriously diseased.

The forest canopy should include, per acre, at least 15 trees of wildlife food value. This amounts to 5 percent to 10 percent of full normal stocking. In the outer portion of the woodland, the percentage of wildlife food trees should be much higher, even to the entire stand, provided enough species are present in adequate numbers and that a reasonable part of them will also furnish harvestable wood products.

Density of the understory is controlled largely by crown density. The crown should be open enough to permit a good understory of shrubs and young trees,

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WILDLIFE AND THE RANGE

by Lawrence V. Compton [1]

THE importance of the range as the natural environment of western wildlife has been generally overlooked. This is true partly because many of the principles of wildlife management were developed in the eastern States where cultivated farm lands are the rule. Although considerable wildlife research has been done in the western States, relatively little attention has been given to wildlife management.

To those who have lived in the West or are familiar with that extensive country, the range is a fairly definite concept. To them, it usually evokes the mental picture of rolling grasslands, shrub-covered hillsides, open woodlands, and magnificent forests, with tall mountains in the background, all surmounted by a deep blue sky.

The range is that area west of the one hundredth meridian, supporting primarily native forage plants and used mainly for the grazing of domestic livestock. According to the best estimate it aggregates about 728,000,000 acres out of the total 975,000,000 west of the one hundredth meridian. This means that the range covers approximately 40 percent of the United States. It is a varied land of plains, plateaus, valleys, and mountains. It is clothed sparsely in some places, abundantly in others, with grasses, shrubs, and trees, and the climate is essentially semiarid in type. Because of the limitations imposed by topography, soil, water, and climate, only a small portion can be used for agricultural pursuits other than grazing.

Western wildlife, with the exception of a few introduced forms, consists of species adapted to existence in this type of habitat. For the most part, they reached their maximum numbers under natural range conditions and they continue today to be dependent upon the range rather than upon the limited cultivated lands of the West for much or all of their food and cover.

Farming is practiced on about 4 percent of the land of the western States. This relatively small amount of cultivation has little, if any, beneficial effect upon the general population of game animals. In fact, by the high human utilization of water, the clearing of brushy bottomlands, the reduction of winter foraging ground, and the introduction of disease and domestic predators, it has had a definite limiting effect upon wildlife. These detrimental factors have greatly offset the beneficial ones that ordinarily accompany western cultivation, such as the introduction of weeds and cultivated grains, and the presence of irrigated fields and brushy ditch banks. The ring-necked pheasant and Hungarian partridge and the eastern bobwhite have been introduced in many places and have become established mainly in the agricultural lands, but these birds have not done well on the open range. While there is some evidence that nongame species of wildlife have increased with cultivation, the beneficial and detrimental factors seemingly are balanced when we consider the amount of brushland cleared and marshland drained.

With these exceptions, the wildlife of the West is range wildlife. Elk, deer, and antelope are browse-eating species; they find their food on the range and enter cultivated lands only when pressed by hunger. Turkey and grouse live in woodland and seldom have an opportunity to venture into cultivated fields. Sage hens like alfalfa, but they must have sagebrush in order to thrive, and when the sagebrush disappears, so do they. Rasmussen and Griner have shown that 77.5 percent of the food of the adult sage hen consists of two species of sagebrush, and that their nests usually are protected by these shrubs and are never a great distance from them. The western species of quail, particularly the valley and Gambel's quail, are often abundant in irrigated valleys, but they regularly forage on to the adjoining range land and are dependent upon it for a great part of their food. Gorsuch considers the typical habitat of Gambel's quail as the brush type where shrubs afford needed shelter and where food also is plentiful. This is not a habitat ordinarily associated with cultivation. It is the range, not the farm, that furnishes nesting and resting places for migratory waterfowl. And so it is with almost all western wildlife—its home is the range, and in spite of occasional green fields, the range continues to be its main reliance.

The serious decline of western wildlife and of the range have gone hand in hand. Bison have been reduced from millions to a few thousands, and these lead a semidomestic life behind fences. Nelson placed

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the original population of the prong-horned antelope at not less than thirty to forty million individuals. The present population is estimated to be 65,000. The bighorn sheep and the mountain goat have almost disappeared and it is generally felt that the few that remain are not holding their own. Under pioneer conditions, the sage hen was found in at least 14 western States and was considered the leading game bird in 9 of these, but its range has been restricted and its numbers lowered until during the past 5 years it was considered the leading game bird in only Montana, Wyoming, Idaho, and Nevada. In 1937 the season was closed in Wyoming, and greatly restricted seasons were inaugurated in Idaho and Nevada. Big-game mammals, upland game birds, waterfowl, and fur-bearers have all been greatly reduced in numbers, and this decline, in spite of increased restrictive legislation, continues today.

The destruction of the range itself has been no less severe. Throughout its 728 million acres, deterioration has been almost universal. The range has been depleted approximately 52 percent from its virgin condition, and here depletion is used in the sense of reduction in grazing capacity for domestic livestock. This means that the range once was capable of supporting 22.5 million animal units, but that now it can carry only 10.8 million. This depletion consists of the disappearance, largely or altogether, from many parts of the range of valuable forage plants; the replacement of perennial grasses by less nutritious annual grasses and weeds; and the marked reduction in density of the better forage plants. This decrease in forage has been accompanied by accelerated erosion, destruction of valuable watersheds, siltation of reservoirs, loss of stock waters, and lowering of water tables. The primary cause of the destruction has been overstocking.

Various explanations have been advanced for the disappearance of western wildlife. Although introduced diseases, abnormal weather, and predators may have contributed after the decline had reached critical proportions, it must be recognized that the primary causes of the depletion of wildlife have been excessive hunting and trapping and the destruction of the range environment.

The importance of hunting and trapping in effecting the initial depletion of western wildlife should not be underestimated. This was a systematic, big-scale business conducted for profit, and its effect upon the population of game and furbearing animals was devastating. Over the western United States as a whole, wildlife even yet has not recovered from the trapping, market hunting, and general hunting that occurred during pioneer times. Market hunting has now been fairly well eliminated; but bag limits, length of season, and locale of hunting and trapping are by no means regulated according to the harvestable crop.

Meantime, the white man, with his insatiable desire for more land and his frequent misuse of what he has, has succeeded in destroying not only the environment of wildlife, but in many places his own as well. Overgrazing and submarginal farming have needlessly reduced the vegetative cover. Domestic and industrial requirements, irrigation, and stock watering have lessened and, in some places, eliminated water for wildlife. Farming has taken food and cover from the valleys. Drainage has destroyed the waterfowl breeding grounds; and human occupation has forced upland wildlife, particularly big-game mammals, to winter on the summer range.

The requirements of range wildlife are adequate food, cover, and water, on both winter and summer range. The provision of these necessities, coupled with effective regulation of hunting according to annual production, will make possible the management of wildlife as a harvestable product of the land. It is to the restoration of environment that the efforts of the Soil Conservation Service are directed; the regulation of hunting is a responsibility of the States and the landowners.

The biologist works hand in hand with the range manager in reconstructing the range so that the needs of both domestic livestock and wildlife will be met and soil and moisture conservation problems solved. Wildlife food and cover are increased through the regulation of grazing—by establishing proper livestock numbers, fencing, and water development. This permits better distribution of livestock and lighter utilization of forage, allows the production of a correspondingly more effective soil cover, more dependable forage supplies from year to year, and more abundant vegetation for the use of wildlife.

The retirement of submarginal grazing lands and areas of critical erosion hazard from livestock usage serves to restore the normal balance between winter and summer range for wildlife and curbs some of the most serious cases of accelerated erosion.

Development of stock water is potentially either beneficial or harmful to wildlife, depending on how the work is done. A spring that is cased and led to a trough is often lost to all except the largest animals and frequently is a death trap for the smaller ones. If a ramp or steps are placed in the trough, however, the spring continues to be safely available to all

wildlife. The life of surface reservoirs may be greatly lengthened by planting aquatic vegetation along their margins, establishing desilting plots on the waterways, and fencing all but the approaches for stock. This procedure not only ensures a longer life for the reservoir, but it makes valuable wildlife habitat out of the otherwise barren and trampled area that usually surrounds stock watering places.

Stream bottoms are important in the wildlife environment. Some species are restricted to such habitats while others are dependent upon them to some extent for food, cover, and water. The fencing and planting of stream bottoms is at once an important erosion-control and wildlife-management measure. The restriction of grazing combined with the planting of carefully selected plant species results in rapid vegetative recovery, reduction of stream velocity and of erosion, and greatly improved environment for wildlife.

Experience has shown that these conservation practices do increase wildlife populations. Becenti's Lake, 8 miles northeast of Crown Point, N. Mex., is a stock water reservoir of 30 surface acres. The reservoir and a small area surrounding and above it were fenced as a desilting plot, stock was excluded, and small amounts of woody and aquatic vegetation were planted. Prior to construction of the dam, the valley bottom in which it was built was badly eroded. The dam reduced gully erosion below the reservoir and filled many of the gullies above it. The fenced desilting plot brought a marked increase in vegetation which caused deposition of much of the silt before it could reach the reservoir, although the countryside outside the fenced area continued to be overgrazed and remained in much the same condition as it was at the time the plot was fenced.

Three years after the establishment of the desilting area, Gale Monson, Soil Conservation Service biologist, made a count of the wildlife that could be found on it and on a comparable area (but without a pond) outside. In the desilting plot 137 individuals of 11 species of native birds were counted; in the outside plot, 76 individuals of 3 species. Of the birds found inside the desilting plot, the occurrence of 5 species and 23 individuals was attributable to the availability of water. The presence or increased numbers of other species was directly attributable to the increased vegetation.

The Steamboat Demonstration Area on the Navajo Indian Reservation provides another example of effective wildlife habitat improvement and soil and moisture conservation. Here proper grazing practices were prescribed and maintained, fences were built to control the distribution of livestock, woody plants of value to wildlife were used for erosion control, and structural treatments were employed to stop soil wash and increase the availability of moisture for forage production. A wildlife census of plots inside the area and of comparable plots outside showed that the number of individuals was doubled within the demonstration area, although the number of species remained the same.

It must be recognized that wildlife has both tangible and intangible values to human society. It has been estimated that in the range area, the expenditures by sportsmen for equipment, travel, food, and other necessities for hunting in the season or 1930–31, were $40,300,000; tourist expenditures on national forests within the range area were $155,000,000; and the annual value of meat and fur in the area is placed at $87,250,000. The expenditures by the sportsmen were directly due to the presence or supposed presence of wildlife. It is impossible to estimate how much of the tourists' money was spent for the privilege of just looking at wild creatures with no thought of shooting them; it must be an appreciable amount, however, for the appeal of animals is universal. The monetary value placed upon wildlife is very great, but this represents only the cost of outfitting and getting into position to appreciate wildlife; it cannot represent the human well-being brought through recreation and purely esthetic pleasure. It is obvious that wildlife is a natural resource that plays a definite and valuable part in the economic and social life of the West. These assets make it desirable that wildlife be managed as one of our valuable renewable resources.

Good administration will not permit the development of conflicting conservation programs on public and private lands, and good economics will not permit the use of any land without continual reference to what is the major use of land today; namely, agriculture. A conservation program which leaves out of consideration the owners and users of more than half our total land area does not make much sense. The national program of land use which has been taking shape during recent years in the Department of Agriculture begins with this major use of the land and seeks continuous integration of this use with all others . . . wildlife conservation will continue to hold its proper place in this program.—Henry A. Wallace.

Muskrats help to pay the taxes on a small 66-acre farm in southern Michigan, where about $75 is received each year from the sale of muskrat pelts.

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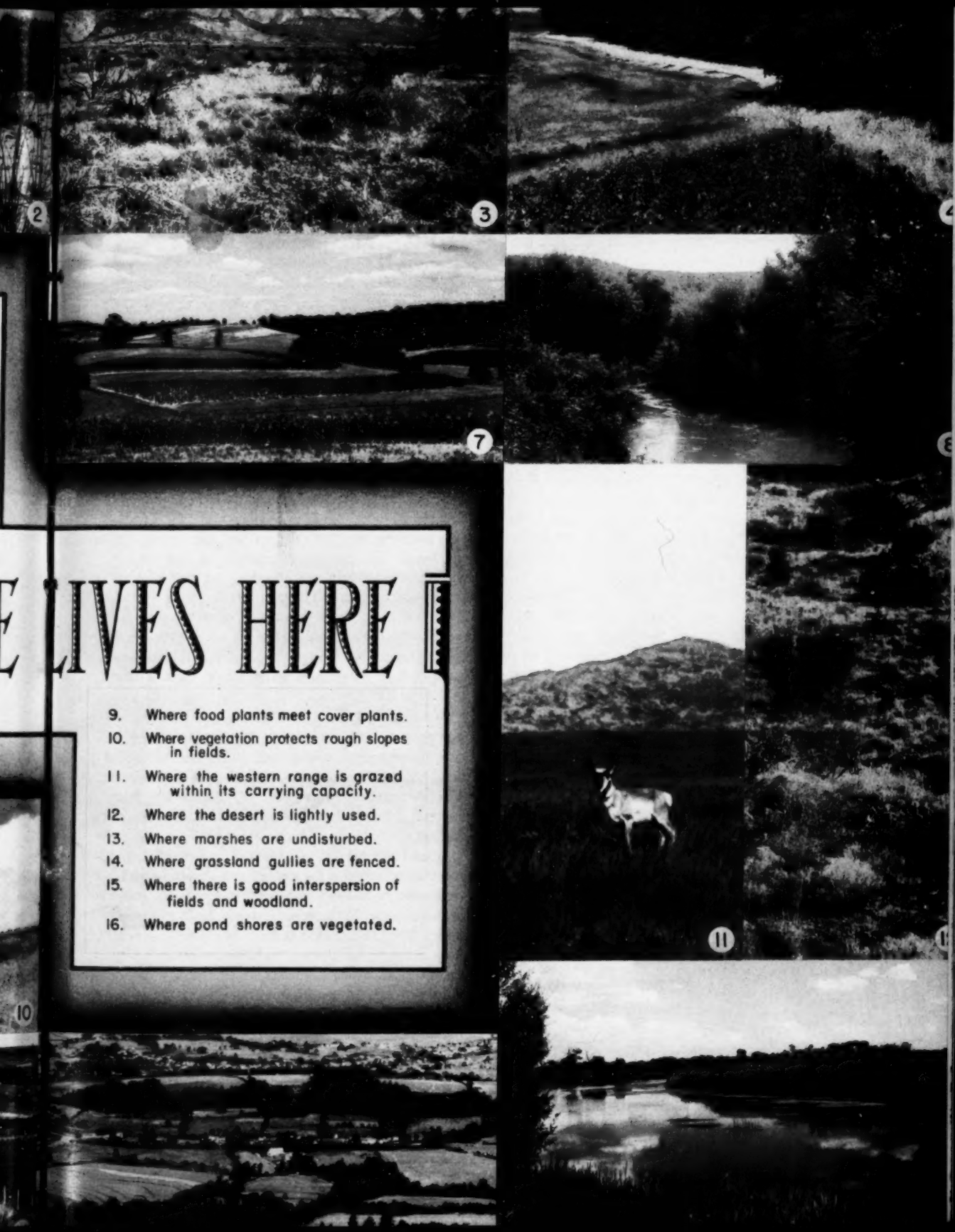
1. Where shrubs provide nesting cover and food.
2. Where natural habitats are preserved.
3. Where ground-nesting species find grassy cover.
4. Where field borders supply food near woodlands.
5. Where fence rows provide travel lanes and refuge cover.
6. Where woodland understory is well developed.
7. Where strip crops vary vegetation.
8. Where banks are protected and streams run clear.

WILDLIFE LI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E LIVES HERE
9. Where food plants meet cover plants.
10. Where vegetation protects rough slopes in fields.
11. Where the western range is grazed within its carrying capacity.
12. Where the desert is lightly used.
13. Where marshes are undisturbed.
14. Where grassland gullies are fenced.
15. Where there is good interspersion of fields and woodland.
16. Where pond shores are vegetated.
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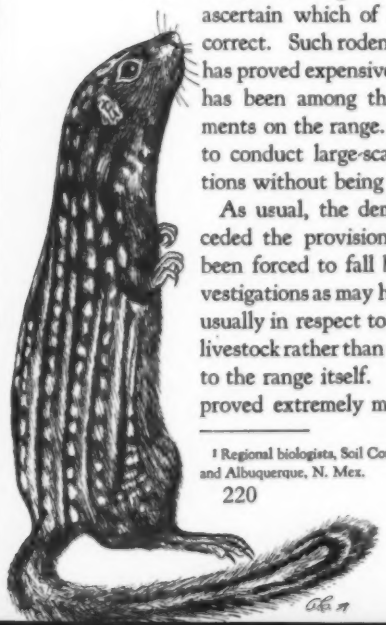
RODENTS AND SOIL CONSERVATION

By Richard M. Bond[1] and Adrey E. Borell[2]

IN THE execution of a program of soil and moisture conservation in the West, we are immediately confronted with the problem of what to do about rodents. Some people tell us that our program can be nothing but a failure if we do not control these animals; that they will break our dams, that they will increase erosion, and that they will not permit grass to return to the overgrazed range. Others tell us that rodents are beneficial agents in the building of soil; that they cannot do appreciable damage to well-made dams; that their presence in large numbers is a result of overgrazing, and that the operation of our program in itself should do much to reduce rodent populations.

These are diametrically opposed views; it can hardly be possible that both are correct. But it is important that we know which is correct if we would formulate our program on a biologically sound basis. The Soil Conservation Service was set up specifically to effectuate a national program for the conservation of soil and moisture. The keynote of this program, as expressed by the Congress, is the control of erosion. Therefore, if the control of rodents has no important bearing upon the control of erosion, we should dismiss the idea and direct our thinking towards more promising activities. On the other hand, if rodent control does have a legitimate place in our program we should have definite proof of that fact, and then utilize rodent control as we would any other acceptable erosion-control measure.

Sound business management also demands that we ascertain which of these opposing views is correct. Such rodent control as we have done has proved expensive; in fact, its per-acre cost has been among the highest for land treatments on the range. Hence we cannot afford to conduct large-scale rodent control operations without being sure of our ground.



As usual, the demand for action has preceded the provision for research. We have been forced to fall back on such sporadic investigations as may have been made by others, usually in respect to rodent competition with livestock rather than to the relations of rodents to the range itself. The available data have proved extremely meager, inconclusive even in respect to the influences studied, and wholly unsatisfactory from a soil conservation viewpoint.

A recent bibliography lists 8,229 important books, articles, and other publications dealing with the western range. Of these 216 come under the heading "Control of Range-Destroying Rodents." From a perusal of these papers it becomes obvious that the majority of the authors regard rodents in rather a baleful light. Where rodents invade cropland, and eat corn and alfalfa, or girdle fruit trees, there is excellent reason for such an attitude, but it is surprising to learn how few people differentiate between what rodents may do on cropland and their activities on the range where conditions—and therefore effects—may be quite different. It is surprising also to discover how few of the authors seem to realize that an animal, even though a rodent, may possibly do more than one thing; in other words, that a cause can have more than one effect, and an effect more than one cause. The number of scientific studies of just what it is that rodents do to the land, or just what any one kind of rodent does to a given piece of land, may be numbered on the fingers of one hand. No careful study has been made of *all* the effects of the rodents on a given area, and no study at all has been made of the bearing that rodents may have on soil and water conservation.

Vegetation is our first defense against erosion. The presence or absence of vegetation depends upon many factors, important among which are soil conditions and plant utilization. What part do rodents play in the development and application of these factors? There is no question that certain rodents will eat plants that a cow or a sheep would otherwise consume; but we are not justified in assuming that plant destruction is the only thing accomplished by these rodents, unless this is demonstrated by thorough investigations. Such investigations have not been made, though they are needed badly, and have been needed for many years. True, there are some suggestive items in the literature, but most of these are in the nature of essays by scientists, rather than scientific studies. Curiously enough, the more profound investigations seem to have turned up bits of information favorable to the rodents. Studies on desert soils in Arizona by Greene, Reynard, and Murphy have shown that each banner-tailed kangaroo rat adds to the soil plant nutrients, espe-

[1] Regional biologists, Soil Conservation Service, Santa Paula, Calif., and Albuquerque, N. Mex.

cially nitrates, that would cost about 30 cents to apply in the form of commercial fertilizer. The kangaroo rats also bring about aeration and increased water percolation, due to burrowing, and are responsible for a considerable increase in organic content because of the plants and other material brought into their burrows. The actual water-holding capacity of the soil is also considerably increased, largely by the mixing action of their digging. Desert wood rats were shown to have the same effects, but to a less marked degree since their burrows are less extensive.

Grinnell, in discussing the burrowing rodents of California, postulates that the native plant cover is the most important single factor in conserving soil and water, and then explains the relationships between the vegetation and the native animals. About one-fourth of all the kinds of mammals in the State are burrowing rodents, and these comprise at least one-half of the total mammal population. The most widespread and abundant are the pocket gophers. Together with Storer, Grinnell calculates that the gophers in Yosemite National Park annually move an average

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WHAT TO DO

C. B. MANIFOLD,
Chief,
Division of
Conservation Operations.

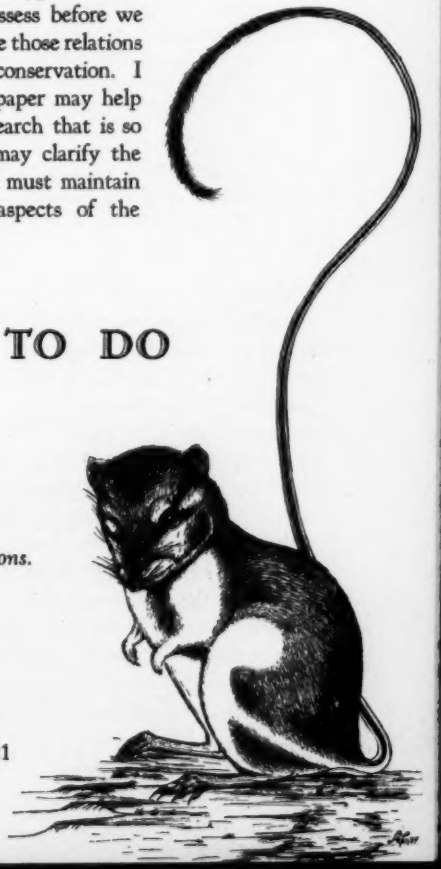
PERHAPS the most vexing—by all odds the most persistent—problem of our western biologists revolves about rodents. Were the problem merely biologic, it would still be serious enough, for while rodents are the most numerous of all mammals, we know but little of their ecology. The biologic phases of the problem, however, are considerably complicated by economic considerations, and sometimes both are overshadowed by psychologic factors.

In its simplest terms the problem is this: Should funds appropriated for soil conservation be used to control rodents? There are two schools of thought on this subject, even within the Service, but decision as to policy rests with the biological staff. Because the biologists consider the price of control measures high in proportion to benefits that are transient and of doubtful value to soil conservation, the question has been much debated.

Unfortunately the whole controversy has arisen over a symptom and has diverted from the disease itself the attention needed to effect a cure. That overstocking by domestic animals lies at the root of the real ills of the western range is beyond any question. Yet it often happens that a ranchman, when asked to cut his livestock numbers in the interest of soil conservation, blames the rodents for the condition of his range and demands rodent control as the price of stock reduction. The fact that it is not the policy of the Service to buy acceptance of its program, or to spend money where the erosion-control justification is not clear, does not impress a man who believes that rodents consume as much forage as does his stock, and who is anxious to find arguments against reduction. In fact, overemphasis on damage of rodents has consistently hindered the progress of our range program.

Moreover, the Biological Survey is prepared to help ranchmen with their rodent problems. It is entirely right and proper for the Biological Survey to demonstrate methods of rodent control, and to carry out control operations when the Congress has specifically appropriated funds for that purpose. It must be clearly understood, however, by our own staff and by our cooperators that such rodent control as we may do, or require to be done, must be necessary for the attainment of the Soil Conservation Service objectives—soil and water conservation.

So much pressure has been brought on the Service to do rodent control that I have asked our two regional biologists most concerned, Messrs. Bond and Borell, to discuss briefly the present state of our knowledge concerning rodent-soils relations, and to point out the type of information we must possess before we can properly evaluate those relations in terms of soil conservation. I greatly hope their paper may help to stimulate the research that is so badly needed, and may clarify the position the Service must maintain until the biologic aspects of the problem are solved.



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of 3.6 tons of earth per square mile from underground up to the surface, and as a result the formation of soil is hastened by the burrows which carry air, water, and dissolved matter to the subsoil. The subsoil is broken up and brought to the surface where it is still more rapidly weathered; the increased soil porosity makes for better moisture retention; and organic litter on the ground is buried by the dirt thrown out by the gophers and is thus incorporated into the soil. These activities of burrowing rodents on ground that is not overgrazed all tend to prevent erosion.

Most of what is known, or rather, suspected, of animal relations to soils has been summarized by Walter P. Taylor. He concludes that there seems to be little or no evidence of a critical character that rodents under natural conditions promote soil erosion. Later, Van Dersal, on a quest much like our own, brought Taylor's summary up to date, and summarized a number of papers that were not accessible to Taylor. Van Dersal condenses his study of the literature as follows:

> To summarize, careful analysis of the studies so far made of the effect of animals on soils insofar as the conservation of the soil is concerned, leads definitely to these conclusions:
>
> 1. Animals that by trampling or other means compact the surface soil tend to increase run-off and, consequently, intensify any erosion hazard that may be present.
> 2. Animals that burrow into the soil and thus increase its porosity tend to reduce run-off and thereby decrease the erosion hazard. The latter conclusion is not invalidated by the rare, isolated instances, where through combinations of circumstances often directly traceable to the intervention of man, rodent burrows have been shown to be primary causes of erosion.
> 3. In general, animal presence and activities in soils materially assist in the mixing, loosening, aeration, drainage, and fertilization of soils, thereby permitting the increase of plant life, and by a combination of all these factors promote the conservation of soils.

We hear much regarding rodent damage to earthen water-controlling structures. Many people are convinced that rodent control is utterly essential to maintenance of such earth structures; others are equally positive that any dike, dam, or reservoir that requires rodent control for its preservation is not properly constructed, and is doomed to a short life even if no rodents are present. Here again, as with other phases of the problem of relationship of rodents to soil and moisture conservation, our data are inadequate regarding what kinds of rodents damage what kinds of structures, the nature and seriousness of this damage, the extent to which alterations in design of structures may reduce or eliminate rodent damage, the actual effectiveness of rodent control in relation to structure protection, and the cost of repairing structures in comparison with the cost of frequent rodent control. Much more information is necessary before we can justify extensive rodent control for the protection of structures.

As we go over the literature it appears at first sight that rodents do both a great deal of harm and a great deal of good, that they cause and prevent erosion, that they should be at once encouraged and exterminated. This rather startling conclusion may mean that rodents in some areas are doing more harm than good, and in other places more good than harm; or it may mean that under some conditions the harm is easier to recognize than under others—that the good is seldom obvious, even when very real.

It is clear enough, however, that the relations of burrowing rodents to soil and moisture conservation constitute a very complex problem. Consideration must be given to all the effects on plant cover, and to the effects of this cover on erosion as well as to the direct effects of the rodents on the soil. If we are to know just what are the relationships of rodents to the conservation of soil and moisture, we must be able to answer many searching questions.

For example, to what extent do rodents actually compete with stock for range forage? Because of many complicating factors, usually neglected, competition should be measured in terms of livestock gains or days of grazing, and not by weighing or counting plants. Also it must be determined for several rodent species, with different kinds of livestock, in various climates, on different types of soil and vegetation, in wet years and dry, and throughout a considerable period of time.

How much good do the different rodents perform, under different conditions, in improving plant growth by aerating and mixing the soil, and by adding plant nutrients to it? Under what conditions and to what extent do these beneficial effects counterbalance the competition for forage?

Under what conditions do what rodents decrease run-off and add water to the soil, and how much? How much is this effect counterbalanced by soil denudation, and packing by certain kinds of rodents? Under what conditions do the various rodents increase soil erosion by their burrows, and how much of this effect is counterbalanced by decreasing run-off?

Obviously, the most important answers will be those dealing with land that is conservatively used. Unhappily much of the West is so overgrazed that the domestic stock is ruining the vegetation, and causing soil erosion. Rodent effects under such conditions may easily be very unlike those under proper land use, and can hardly be important. Unless the numbers of livestock are reduced to the safe carrying capacity of

the range, the vegetation, and even the land itself, is doomed whether there are rodents competing with the stock or not.

Getting answers of any value to these questions will take time. It seems likely that an improvement in the range could be noted the first year after rodents are extirpated, as the soil will still be mixed, plowed, and porous, and the added plant nutrients will not have been exhausted. It may take many seasons for the soil to pack down so that all the rodent effects are lost, and it is only then that we should be able to tell whether rodent eradication was good or bad for the land. Not only must these studies be made over a long period, but they must be made on large areas. The smaller the area studied, the easier it is to determine exactly what happens to that particular plot of ground, but the more difficult it is to simulate average conditions on the open range, and the more dangerous it becomes to make sweeping generalities from the findings.

General observations and thoughtful inferences, though of the greatest value, cannot take the place of long-time, well planned, carefully thought out, and accurately executed scientific study, and until such work is actually effected, we cannot know whether or not the control of rodents will aid the control of erosion. Clearly, then, caution in the expenditure of soil-conservation funds for rodent control is definitely indicated.

HEDGES CONSERVE SOIL AND WILDLIFE

(Continued from p. 209)

our "hedge rows" as typified in sections of the Midwest by rows of Osage-orange trees. Generally they are 5 or 6 feet high, growing in dense thicket, and often are given the care we might give to ornamental hedges in connection with landscaping home grounds. Less trimming is done in France, but the hedges generally are not tall and consequently they do not exert a depressing effect on the yield of adjoining crops. Hedges are frequently used as fences to control live-stock, thus eliminating the expense for fencing materials.

While making the tour I had little opportunity to study the species of trees and shrubs used for hedges, although it was apparent that the hawthorn is commonly used. Hazel, privet, holly, and even maple, elm, and ash were growing in hedges.

The use of hedges has been a subject of much discussion in this country. There are many people who advocate their use and likewise many who oppose it. In general, it may be said that hedges, as properly used for contour planting on slopes—as fences, for erosion control, and for wildlife cover—are practically nonexistent in this country, and I believe that an opportunity exists for encouraging such plantings. Certainly, on long slopes where strip cropping will not control erosion and where terracing is impractical because of lack of proper outlet facilities, contour hedges should be tried. Undoubtedly the result will be the development of bench terraces, but there are many situations in this country where apparently there is no other alternative for the continued production of crops.

The value of trees planted in rows, as windbreaks, for the prevention of wind erosion and crop damage, is well recognized in several localities in the Western States. In the Salinas River Valley of southern California, rows of eucalyptus effectively protect citrus and other fruits, and also truck crops grown under irrigation, from wind erosion and actual wind damage. The Lombardy poplar is used extensively in row plantings for wind protection along the Columbia River above The Dalles, and also in many irrigated sections of Utah. The practicability and effectiveness of the practice depends on local conditions, including soil type, abundance of moisture, wind velocity, use of proper tree and shrub species, and many other factors.

It has been stated that hedges harbor insects that attack crops. This may be true in some instances; but it must be admitted that they furnish protection for birds and predacious insects that feed on many insect pests. It seems to me that the planting of hedges within the limits of practicability and common sense would be a step toward restoring nature's balance on agricultural lands.

IMPROVING FARM WOODLAND

(Continued from p. 214)

yet not so open that the undergrowth becomes rank over large areas. A density of 60 percent to 80 percent usually yields an understory of desirable spacing.

Where shelter of a natural type is inadequate, some of the slash from cutting operations may be piled. This is always beneficial where rabbits are especially desired.

Brush piles should be large and loosely constructed. Where possible the brush should be piled on a stump or other object in order to ensure looseness at the bottom. In piling, the brush should be thrown at random rather than evenly, with the coarser limbs at the bottom. About 12 feet in diameter and 8 feet in height is a good size, and two to four such piles per acre is a good spacing, depending on the need for additional shelter. Other slash should be lopped and scattered.

PUTTING ERODED FIELD BORDERS TO GOOD USE

By Verne E. Davison[1]

ACTING on the well-known maxim, "Wildlife is a product of edges," biologists of the Service have developed methods of vegetating field borders. It is hoped that crops and woodlands at last can be made to live together as good neighbors, with benefit to farm wildlife, in those parts of the country where farms once were carved out of the primeval forest. The relation of woods to adjacent cultivated fields is commonly an unhappy one in the Southeastern States in particular, and in other sections where pines, oaks, sassafras, persimmon, blackberries, and numerous other woody plants stand ever ready to reclaim the lands wrested from them by the ax and the plow.

A farmer must resist this encroachment on lands profitable for field crops. But, despite his ability to prevent the growth of new seedlings, the roots of maturing trees will draw plant food and moisture from beneath the field border and seriously curtail the growth of his crops. Here lies a zone of transition from open field to dense woods, where neither commercial crops nor forest products can be grown successfully. The soil cover becomes thinner here than anywhere else in the field—soil removal is considerably hastened where the border catches the water from the ends of several rows during heavy rains.

Yet it is possible for modified field and woodland vegetation to meet harmoniously at a midway boundary. It is in such places, where the edges of herbaceous and shrubby cover adjoin, that rabbits, quail, mockingbirds, brown thrashers, and other familiar wild animals of the farm prefer to live. Frequently, enough fertilizer and seed are wasted on field margins to pay for establishing cover that would effectively protect the soil and provide almost ideal wildlife habitat.

To gain a clearer conception of this problem a study was made recently of the extent of erosion and loss in crop yields, due to woodland competition, in 100 erosion-control demonstration and C. C. C. camp areas in the Southeastern States. More than 3,500 field borders—principally around fields of tobacco, cotton, corn, and wheat, but including a few fields of lespedeza, cowpeas, and peanuts—were examined. For each, the distances from the edge to points where crop production was estimated to be 25, 50, 75, and 100 percent of the unaffected field were recorded. Other features recorded were soil type, slope, degree of erosion, kind and height of trees, kind of crop, and direction of the field boundary.

These studies indicated that the height and, to a lesser extent, the kind of trees along field edges are the most important factors influencing the width of nonproductive borders. The other factors studied had little effect on the extent of injury to crops. For an average distance of 33 feet from the edges, fields adjacent to all kinds and heights of woodlands produced less than 50 percent of the normal crop. Strips approximately 12 feet wide nearest the trees were uncultivated, although the distance varied.

Some hardwoods, particularly oaks, exert a more pronounced effect on field crops than do pines. In general, woods up to 25 feet in height affect 20 to 27 feet of the field edge; woods 25 to 50 feet in height influence a border of 27 to 35 feet; while those more than 50 feet high extend their competition to a distance of 35 to 45 feet. Greater extremes were found both with the taller and lower woodlands.

The nonproductive border down the slope from a

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Where woodland adjoins cultivated land, there is an area between, on which it is impossible to produce profitable cultivated crops.

woodland is likely to be relatively wider than that above a woodland; this is because the silt and moisture deposited from the field up the slope compensate in part for the moisture used by the tree roots.

These facts offer some guidance in the determination of widths and design of field border plantings to be used with different types of woodlands. In discussing the intervening strips, however, it is well to differentiate between woodland borders and field borders. "Woodland border" refers to the edge of a woodland which is planted or allowed to grow up to shrubs. Its value to wildlife is well known.

New plantings of forest trees were formerly brought to the very edge of land suitable for cultivation. It is now recognized that this practice was equivalent to encroachment on to the cropland itself, as root systems extend to distances of 25 feet or more before the planted trees produce any harvestable crop. It is therefore logical to use shrubs instead of trees for the outer portions of plantations abutting on cropland. Two rows of shrubs spaced 6 by 6 feet are recommended as a minimum. If the wood is for growth to sawlog size, it is advisable to increase the shrub border to 3 or 4 rows.

"Field border" refers to the margin of a field where a herbaceous strip is established for wildlife food and cover and for the protection of the soil. This border must be designed to permit such measures as mowing, cutting, plowing, or disking, so that there will be no further encroachment of woody vegetation on the field.

If the border is crosswise to the direction of cultivation, whether it adjoins a woodland or not, the cover must be sturdy enough to withstand trampling by animals and the turning of machinery during cultivation. It must also provide a vegetated outlet through which run-off water from the individual rows may be guided to a safe place of disposal.

For convenient maintenance with farm machinery, permanent field borders should be uniform in width and fitted to the field rather than to adjacent woods or waste areas. To accomplish its full purpose, the strip must continue the entire length of the problem area. The edge next to the field should reach the point where average crop production is not satisfactory. A width of 10 to 20 feet is recommended for turn-row, water disposal, and wildlife food purposes. Woodland or gullied areas on the edge away from the field are considered separately. A shrub border to a woodland usually fits closely against the field border so that both become wildlife improvements, each supplementing the other.

On field borders to be used as turn rows, a perennial legume, *Lespedeza sericea*, has demonstrated its value as a dependable erosion-control plant. For borders adjoining woods, it is particularly reliable because of its tolerance to shade and its deep roots which adequately compete with tree roots for soil moisture. *Lespedeza sericea* is seeded following a rain, between February 15 and May 30, at the rate of 15 pounds per acre on well-prepared soil which has been rolled or allowed to settle. An annual lespedeza, browntop millet, or Sudan grass is sometimes added to furnish temporary ground cover. On sites where more than 75 percent of the topsoil has been removed, a light covering of pine boughs, grain straw, or other similar material may be used to supply this protection.

Where edges of herbaceous and woody vegetation meet is where rabbits, quail, thrashers, and other wild birds and animals of the farm prefer to live.

If the border is parallel to the direction of crop rows, and therefore is not needed as a turn-row or water disposal channel, partridge peas, annual lespedezas, or browntop millet may be used alone.

Maintenance of field borders is necessary to retard the invasion of plants such as broomsedge, shrubs, and trees. Each of the annuals mentioned above will reseed itself and remain the predominant plant if plowed or disked as unwanted species appear. Perennial herbaceous borders may be maintained with the ax, mowing machine, disk, or plow. Cutting of larger trees in the woodland border is sometimes necessary to prevent encroachment into the field and to release shrubs for more abundant food production.

A larger variety of plants adaptable to field borders is needed for a greater contribution to the welfare of wildlife, and for this purpose several native species are being studied in nursery and field trials. Meanwhile it is advisable to depend upon the proved lespedezas and to determine definitely the best methods of maintaining them.

CASH IN THE RANCHER'S POCKET

By Homer G. Towns [1]

BOTH by legislative declaration and by existing public sentiment, wildlife belongs to the people of the State. Although wildlife is produced on private lands, legally there are attached to it no private rights. Nevertheless, in some sections of Texas the traditional system of free hunting has given place to one by which the landowner may be remunerated for the game raised on his property. Though without rights of ownership, in the game itself, the landowner who protects wildlife, and controls ingress to the land occupied by it, is now conceded to have the right to charge the hunter for the privilege of shooting over his holdings.

The new system has been in operation long enough (8 to 15 years) and on a scale large enough, and has met with sufficient success, to be worthy of consideration by all interested in the restoration of upland game. Some ideas of the acreage and cash involved, in at least one part of Texas, may be gained from the following list of 1938 hunting leases courteously supplied by the Kerrville Chamber of Commerce:

1. Dan Auld; 3,300 acres; 20 deer and 30 turkeys allowed for $1,000 cash.
2. Albert Kramer; 2,332 acres; leased to 8 hunters for $500 per annum.
3. Pat Rogers; 700 acres; leased to 3 hunters for $150 per annum.
4. Gay Sieker; 1,000 acres; leased to 5 hunters for $150 per annum.
5. Johnson Ranch; 3,000 acres; leased for $1,000 per annum.
6. Live Oak Ranch; 5,000 acres; 20 deer and 30 turkeys allowed per annum; leased for 5 years for $10,000 cash in advance.
7. Mrs. A. T. Whitstone; 3,000 acres; leased to 10 hunters for $325 per annum.
8. Ruth Griffin; 960 acres; leased to 2 hunters for $200 per annum.

In discussing these shooting preserves several points should be considered. In the first place, the landowners have learned that sportsmen are willing to pay for the privilege of hunting on lands where some effort is being made to maintain wildlife populations. Second, apparently it is only where sportsmen pay for the privilege of hunting that there are satisfactory farmer-sportsman relationships in this section of the country. The ranchers receive sufficient returns to justify definite efforts toward game restoration, and the sportsmen are happy to pay the price because they know that game is to be had on these ranches.

A third point concerns the fact that the landowners have learned through experience that deer and turkey populations cannot be maintained on heavily overgrazed ranges. W. O. Harwell, manager of the Kerrville Chamber of Commerce, writes that "wise grazing practices ensure a more bountiful supply of game. We know of many instances where hunters have gone out to look over land offered for lease and then refused even to bother with making a detailed examination of the ranch when they saw how closely the grass was grazed."

The fourth point for consideration concerns rigid control of hunting. The owners have learned that such control is necessary to maintain deer and turkey populations. This principle is demonstrated by the records of the Texas Game Fish and Oyster Commission which show that those ranchers who designate the number of deer and turkey to be taken each season are those whose leases are most in demand and those upon whose lands the most deer and turkey are being killed. According to the commission's report for 1936–37, there have been shooting preserves in west Texas for the past 12 years; and in five of the counties, landowners, as shooting preserve managers, have maintained rigid protection of their game and these counties have produced one-half the kill. This is the record today with over 6,700,000 acres in shooting preserves in about 70 counties. The ratio was the same 7 years ago when there were 2½ million acres in preserves in 34 counties. The ratio has remained constant through the intervening years.

These banner counties now have an annual harvest of over 4,000 bucks on about 1,000,000 acres. If other counties get down to business in the same way, the total harvest eventually should be 25,000 bucks from the shooting preserves instead of 7,683 which was the total for the past season.

(*Continued on p. 232*)

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DOES WILDLIFE MANAGEMENT PAY ?

PROFITS FOR THE FARMER

By Charles A. Dambach [1] and Ernest E. Good [2]

THAT the farm wildlife crop is widely utilized by sportsmen and multitudes of other recreation seekers from urban centers has been realized for some time, but it is only recently that the management and utilization of this crop has been given due consideration from the farmer's viewpoint. The interest of the sportsman and nature enthusiast is assured, since these persons benefit from the farmer's efforts at little or no expense to themselves. The farmer's interest in maintaining this resource, which only he is in a position to control, depends, however, upon his conviction that wildlife management is a profitable practice on his land.

The returns to the farmer from wildlife management are by no means all economic, and the objectives may vary widely from one place to another. Management may be designed to maintain a population of desirable wildlife, to keep crop pests in check, or to provide permanent erosion-control cover for critical areas on the farm. The farmers may wish to produce fur or game animals to be marketed, either directly or through the sale of hunting, fishing, or trapping rights. To others the assurance of outdoor recreation for the immediate family and friends may be the chief consideration.

Under average farm conditions, wildlife management cannot be expected to return large dividends on a per-farm basis, yet the income per unit of area may be surprisingly large when land not suitable for other crops is wisely managed for wildlife production. Moreover, wildlife is a crop to which all the land of the farm can be made to contribute, over and above its primary function.

On the average farm, intensive management is neither necessary nor desirable. Permanent wildlife improvements are brought about by adjusting land to proper agricultural use, avoiding acts detrimental to wildlife, encouraging the development of vegetation favorable to wildlife whenever consistent with good land use, and using good judgment in harvesting the wildlife crop.

Managed production of fur bearers may yield a worthwhile though small income on the average farm, and more substantial returns on land more favorable for fur management. With proper care surprisingly small areas may be made highly productive. Almost any patch of cattails will produce muskrats if there is permanent water and if the homes of the animals are not disturbed. According to Enders, an acre of such ground, if properly managed, may be made to produce from 10 to 25 muskrats a year. In Ohio muskrat skins bring from 75c to $1.40 each.

At Howell, Mich., where there is much "idle" marshland, one farmer's son has earned about $200 a year trapping muskrats from a hundred acres of marsh with no management. A farmer in the Salt Creek watershed in Ohio has taken nearly a hundred dollars' worth of furs per year from a marsh of less than 20 acres which was created in an abandoned coal-strip area.

A survey in Muskingum County, Ohio, during the 1934–35 trapping season, revealed a total fur crop sold to local buyers of 29,379 pelts with a cash value to the trapper of $26,300.70. The value of furs shipped to mail-order houses was estimated at 15 percent of the total sold to local buyers. This brought the total estimated income from raw furs in the county for this period up to $30,245. On an acreage basis this represents approximately a dollar's worth of fur for each 12 acres of farm land in the county, or an average of about $8 per farm. With proper management, at little expense this income could be increased several fold.

The harvesting of wildlife for food has been profitable mainly to a few individuals who have taken advantage of their neighbors' generosity or indifference. For example, one farmer and his two sons in western Tennessee trapped or shot 400 rabbits, during the open season in 1937, on their own and neighboring farms. The rabbits were sold for 15¢ each, a total of $60.

Hunters harvest by far the biggest share of the annual game crop. This presents a perplexing problem to the farmer who is interested in improving conditions for wildlife but is hesitant to do so because of frequent abuses by the hunters.

Damage to fences and livestock is a constant threat, and attempts personally to control trespass often result in unpleasantness that is most distasteful to the average farmer; he feels that a point-blank refusal to permit hunting on his place would be inhospitable. As a result, all too generally a multitude of friends, relatives, acquaintances, and others, impose upon his good nature until, in desperation, he posts his farm against

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[2] Project biologist, Soil Conservation Service, Mount Vernon, Ohio.

hunting. Most farmers find it easier to tack up "no hunting" signs and hope they will be heeded, than to make a face-to-face refusal to each person requesting permission to hunt. This is well indicated by Lithgow Osborne's report at the Twenty-first American Game Conference, in 1935, in which he stated that two members of the New York Conservation Department, traveling as ordinary sportsmen, were refused permission to hunt at only 1 out of over 40 posted farms at which they stopped.

In many instances farmers who are otherwise interested in wildlife have hesitated to improve or maintain conditions favorable for game because of the certainty of the resultant increase in hunting pressure and its abuses. Some few, however, have worked out various plans by which the number and desirability of hunters can be controlled. Some of these plans have resulted in substantial remuneration from the sale of hunting rights.

Practically all of the systems in use in the Ohio Valley region are based upon the procurement, by persons desiring to hunt, of a written or printed permit from the farmer. Of these, the Williamston plan and the Wood County system have received most notice.

Under the Williamston plan, which originated in Williamston Township, Ingham County, Mich., anyone wishing to hunt must first obtain a ticket from a farmer belonging to the group. On the tickets are the name of the organization and the instructions to the hunter to park his car in the farmer's yard, to be careful with guns and fire, to close gates, and to climb fences at posts. He is reminded to obey the game laws, to be courteous, and is requested to come again. The ticket is issued without charge, and is returned by the hunter when he leaves the farm. The number of tickets per farm is decided each year on the basis of a majority opinion concerning the abundance of game. Usually not more than four tickets are issued to any one farm; this prevents too many hunters being on the land at one time. One of the tickets is often reserved for the landowner or his family.

The organization is generally built around some community enterprise such as a church or school. A president, secretary, and a board of five directors from representative parts of the area are elected each year. The area is posted with signs provided by the State department of conservation.

The Wood County system originated in Plain Township, Wood County, Ohio, in 1930. Different associations sell season permits to sportsmen at prices ranging from $2 to $3.50, making the purchaser a member of the association and entitling him to hunt on any of the lands within its boundaries during the hunting season. The landowner or his children may hunt over the whole territory for 25¢. Other residents of the area who do not own land are charged 50¢ each. The money is used to pay for printing signs and posting the land, employing special deputies to patrol the territory, winter feeding, and various other game-management measures. A part of the annual income may be given to the community church or school, and the remainder is prorated to the farmers on an acreage basis.

Variations of this system are being tried in many parts of Ohio. In the Indian Creek Game Protective Association, organized by Butler County farmers in 1936, each farmer receives a permit for each 15 acres on his farm. He pays the association 25¢ for each permit, and sells it to the hunter for 50¢. The permit is good for 1 day's hunting on the farm of the man who sells it. If he sells no permits he pays 1⅔¢ per acre for protection against trespass. Most of the funds of the organization are used to employ deputies to patrol the territory during the hunting season.

It should be borne in mind that the organization of a managed hunting area is purely a local problem and any such plan must be made to meet local conditions. The Wood County system, wherein the association member may hunt over all of the farms in the area, is satisfactory in northwestern Ohio where similar hunting conditions exist on practically every farm. It is not satisfactory, however, in southwestern Ohio or in other territories where the topography tends to vary the agricultural practices so that some farms provide much better hunting than others. But these problems are readily solved if given concerted thought and effort under capable leadership by farmers and sportsmen with a real interest in perpetuating game.

Control of hunting, however, is only part of wildlife management, though it is becoming increasingly necessary, especially near large urban population centers. A direct cash return from the sale of furs and of hunting or fishing rights is important as an incentive to the farmer to make positive provision for the welfare of his wildlife. The greatest value of sound wildlife management on the farm, however, is biologic, for the natural flora and fauna profoundly affect every farmer in his economic and social relationships with the land.

WILDLIFE IN THE LAND UTILIZATION PROGRAM

By Walter A. Peterson[1]

THE LAND utilization program[2] of the Department of Agriculture has been concerned primarily with effecting needed adjustments in the pattern of land ownership and land use in distressed submarginal agricultural areas. Four major types of development have been planned and initiated on land utilization project areas: (1) grazing, (2) forestry, (3) wildlife conservation, and (4) recreational facilities.

To the end that best results might be obtained in planning wildlife adjustment on land utilization areas, the advice and help of other governmental and State agencies primarily engaged in wildlife conservation were sought. In this connection, 32 projects with a total area in excess of 722,000 acres, located along the principal flyways in 16 States, were purchased for the Bureau of Biological Survey to be developed and administered by that agency as migratory wildlife refuges. Large areas of marshland reclaimed in cooperation with State agencies from unprofitable agricultural use already have demonstrated their usefulness for migratory wildfowl, and for fur bearers, such as otter, mink, beaver, and muskrat. Under the favorable conditions which have been created, and with proper management, the administering agencies should be able each year to obtain substantial fur revenues from these areas. Wildlife censuses, taken before and after work done over a 3-year period, indicate increases far in excess of expectations.

On projects in the Southeast, extensive operations have been carried on to reestablish cover, food, and favorable environment for upland game species, especially bobwhite. Several hatcheries have been constructed for rearing bobwhite and turkey for release on project areas. This stocking, coupled with correction of deficiencies in food and cover, and the closing of the areas to hunting, has resulted in gratifying increases.

Two large hatcheries for the production of warmwater fishes, such as bass and bream, were constructed, one on the Sandhills project near Hoffman, N. C., and the other on the Welaka project near Welaka, Fla. Another hatchery is under construction on the Arcadia project in Rhode Island. The first two are now administered by the Bureau of Fisheries, and upon completion the other will be transferred to the same agency.

On many of the projects, particularly those in the East and South, considerable attention has been given to the creation of ponds and lakes to provide local fishing and to serve as resting and feeding places for migratory waterfowl. Stream improvement also has been undertaken on projects where natural environment gave promise of success for this type of work, and many rearing pools have been constructed to add to the efficiency of the fish restocking activities.

Sanctuaries have been established in cooperation with State agencies for the protection of all types of native wildlife found on the areas. In some instances tracts containing primeval growth and environment were purchased for the perpetuation of species in danger of extinction. For example, primitive areas harboring several colonies of ivory-billed woodpeckers were purchased in Florida and are to be preserved in their native State. On one Minnesota project a small herd of woodland caribou probably was saved from extinction by protective measures and by the introduction of 10 animals from Canada to augment the pitifully small remnant of this species in the continental United States.

The summary shown below indicates the character and extent of wildlife development accomplished during the 3-year period ending with 1938.

Summary of Wildlife Developments on Land Utilization Projects to Dec. 31, 1938

Area covered by biological reconnaissance	acres	192,250
Refuge boundaries cleared and posted	miles	161
Wildlife refuge fencing	do	111.6
Area established as game food nursery	acres	25
Area planted for food and cover	do	32,741
Forest slashings to improve wildlife environment	do	33,141
Game farms and fish hatcheries constructed and operated		8
Game and fish protection and restocking		All areas
Fish and game shelters established		1,989
Fish-rearing ponds established		78
Area covered by lake and pond development	acres	20,949
Stream improvement	miles	573.4
Stream and lake bank protection	acres	88
Dike and jetty construction	feet	142,200
Impounding dams built		326
Diversion ditch construction	rods	583

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[2] The Land Utilization Program referred to in this article was initated under the Agricultural Adjustment Administration, cooperating with the Federal Emergency Relief Administration in the summer of 1934. Its functions were transferred to the Resettlement Administration when that administration was established April 30, 1935. On September 1, 1937, the name of the Resettlement Administration was changed to the Farm Security Administration. On June 9, 1938, land-use projects were transferred to the Bureau of Agricultural Economics, then on November 1, 1938, to the Soil Conservation Service.

UTILIZING FARM PONDS FOR WILDLIFE

By Cecil N. Davis[1]

IN MUCH of the Midwest and West, shortage of water is a serious problem both in wildlife management and in farm and range management. Experience during the droughts of 1934 and 1936 revealed that surface water supplies are inadequate to last through extended periods without rain.

In erosion-control work it has been found that, frequently, the least expensive method of controlling gullies is by means of water-impounding dikes. Likewise, a properly located pond often makes it possible to utilize an eroded cultivated field by converting it to pasture, or to maintain better distribution of the grazing load on present pasture or range and thereby reduce soil loss.

By proper management of surface water the soil is protected from trampling and the water from pollution by livestock, silting may be reduced to a minimum, and the cutting action of waves on reservoir banks may be eliminated. Furthermore, in few other sites is there such close connection between soil conservation and wildlife conservation—with carefully chosen plants, proper planting methods and occasional special treatment, water supply sites may be made into wildlife habitat that cannot be excelled.

The recommendations here presented are the results of observation and experience in Missouri and southern Iowa. They should be useful, however, over a much wider area in the same general region.

Because of their rarity, springs and swamps in this region should have special care. Oftentimes inexpensive structures can be built to concentrate water into ponds where it may support luxuriant marsh vegetation valuable for wildlife food and cover. Fences should be built around such areas.

The needs of a variety of wildlife should be kept in mind when the development of a water area is being planned. If the site is a prairie the habitat should be made suitable for waterfowl and for prairie dwellers native to the area; but a greater variety of species may be served where there are more diversified cover and food conditions. If possible, additional food and cover areas adjacent to the water area should be developed and protected to increase the value of the water facility for wildlife.

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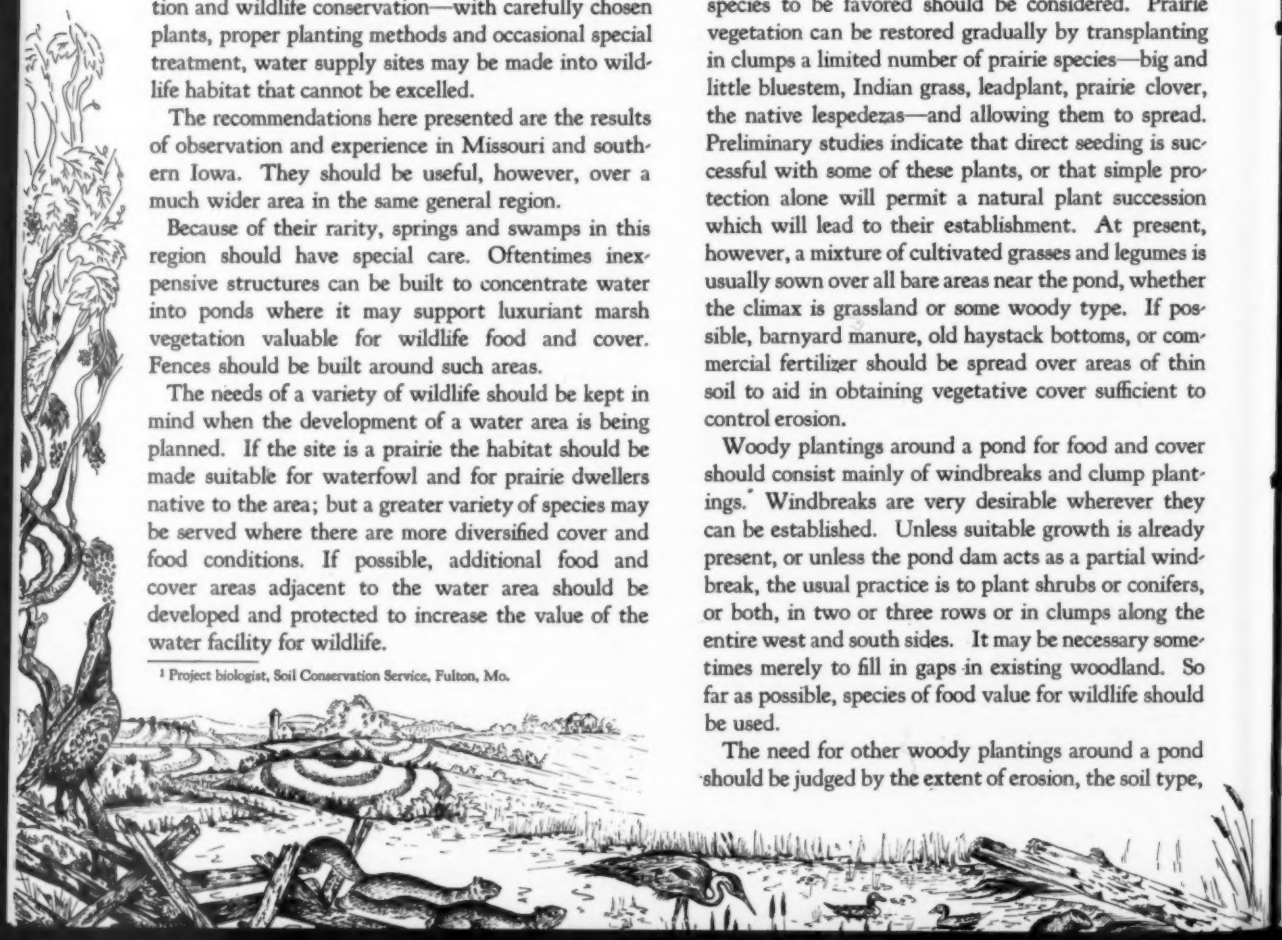
The possibilities of fish production should be considered. On many farms there are brush, logs, sand, and rocks that can be used to make fish shelters and spawning beds; often this suitable material is moved from the site before the reservoir is constructed. Fish screens are often necessary, but care must be taken to prevent clogging.

Of first importance are fences to exclude livestock, and they should be well above the water line to allow a dense cover growth around the pond margins. Livestock is watered outside the fenced area in tanks fed by gravity from the main water supply; or the fence may be inset so that stock can reach one edge of the impounded water. Small watersheds are often fenced with the ponds. In any event, it is essential that erosion be controlled on the entire watershed.

Proper cover both on the entire watershed and on the immediate banks is essential for the protection of a pond or reservoir. In planning these developments the character of the original vegetation and the wildlife species to be favored should be considered. Prairie vegetation can be restored gradually by transplanting in clumps a limited number of prairie species—big and little bluestem, Indian grass, leadplant, prairie clover, the native lespedezas—and allowing them to spread. Preliminary studies indicate that direct seeding is successful with some of these plants, or that simple protection alone will permit a natural plant succession which will lead to their establishment. At present, however, a mixture of cultivated grasses and legumes is usually sown over all bare areas near the pond, whether the climax is grassland or some woody type. If possible, barnyard manure, old haystack bottoms, or commercial fertilizer should be spread over areas of thin soil to aid in obtaining vegetative cover sufficient to control erosion.

Woody plantings around a pond for food and cover should consist mainly of windbreaks and clump plantings. Windbreaks are very desirable wherever they can be established. Unless suitable growth is already present, or unless the pond dam acts as a partial windbreak, the usual practice is to plant shrubs or conifers, or both, in two or three rows or in clumps along the entire west and south sides. It may be necessary sometimes merely to fill in gaps in existing woodland. So far as possible, species of food value for wildlife should be used.

The need for other woody plantings around a pond should be judged by the extent of erosion, the soil type,



the cover already present, and the wildlife species expected to use the area. The requirements of prairie ponds in this connection have been discussed. It should be recognized, however, that some areas not located on prairies may be so isolated from good brushy cover as to approximate prairie conditions. For such locations, unless the enclosed area is large enough to make good escape cover plantings possible, the habitat should be developed mainly for song and insectivorous birds and for waterfowl. This would require few if any plantings in addition to the windbreak.

For typical nonprairie locations, the shrubs and tree plantings for erosion control should include sufficient clump plantings of mixed shrubs and vines to provide good escape cover for quail and rabbits and a travel lane toward other cover outside the protected area. It is advisable, however, to leave a considerable part of the area in grass or other low-growing cover for ground-nesting species of wildlife. As great a variety of adapted plants as feasible should be the goal.

If the reservoir is to be used for fish or wildfowl, deciduous trees should be planted sparingly near the water. Such low species as mulberry, which does not reseed readily but which has great value as wildlife food, are favored for this purpose. A few planted along the south bank of a pond will help to cool the water without making heavy leaf deposits dangerous to fish, or growing high enough to impede the flight of ducks. River birch, red cedar, and black cherry also may be used.

Marsh or aquatic vegetation may be planted in new water areas to serve as a buffer against wave action, to strain silt from inflowing water, or to bind banks against erosion. At the same time, the plants may be chosen for their ability to provide food and cover for upland wildlife, nesting cover and food for wildfowl, and suitable fish habitats.

In a previous article in Soil Conservation (January 1937, p. 153) the importance of marsh and aquatic plants for use on reservoir banks and in shallow water was discussed. Since that time other plants have been introduced successfully into ponds over a wide area. The longer period of observation enables us to include additional species in the list of plants for the southern Corn Belt, and to recommend the use in each pond of at least two species in each class of plants; i. e., the silt-strainers, the bank-binders, and the wave-breakers. In addition we find that it is advisable to include a few adapted shrubs for nesting cover and food, and a few annuals to make quick growth on mud banks in drought years.

All the perennial aquatics are easily transplanted. This is best done in June so that sufficient root growth can be made before winter. Several species may be propagated by seeding.

The silt-strainer group is so designated because these plants form thick growths in silt beds. They are usually planted in broad bands across reservoir inlets from a point several feet above the water line to a depth of 12 inches in the water. Most of the species producing cover for waterfowl are included in this group.

The bank-binders are tenacious species best adapted to grow on the least fertile parts of the pond banks. Plants in this group must be able to withstand both flooding and drought conditions, often within a period of a few weeks, since wide fluctuations in water levels are common in this region.

The wave-breaker group is composed of plants often rooted on the bottom in 2 or 3 feet of water, but with leaves or stems floating on or near the surface. These plants, if aided by windbreaks, are usually able to control waves on small ponds. In larger reservoirs it has been observed that the best supplemental protection is afforded when the banks shelve very gradually into deep water, as where a long delta has been laid down. Quantities of aquatic insects and smaller plants eaten by small fish are supported and fed by the submerged portions of these plants, and much fish shelter is also afforded.

Aquatic shrubs are of value in supplementing the work of both the silt-strainer and bank-binder groups. Other aquatics that occur naturally in springs and spring sloughs also can be planted in spring pools developed for wildlife.

Lists of plants recommended for use in and around water areas in Missouri are presented here in the hope that they may be of use to persons interested in correct plantings.

Species for Planting Above Shore Line

Woody Plants.—*Amelanchier* spp., serviceberries; *Cissus ampelopsis*, heartleaf ampelopsis; *Cornus* spp., dogwoods; *Crataegus* spp., hawthorns; *Diospyros virginiana*, persimmon; *Juniperus virginiana*, red cedar; *Maclura pomifera*, Osage orange; *Malus* spp., crab apples; *Morus* spp., mulberries; *Parthenocissus quinquefolia*, Virginia creeper; *Pinus echinata*, shortleaf pine; *Pinus ponderosa*, western yellow pine; *Pinus sylvestris*, Scotch pine; *Prunus americana*, wild plum; *Prunus virginiana*, chokecherry; *Rhus* spp., sumac; *Rosa* spp., wild roses; *Sambucus canadensis*, elderberry; *Smilax* spp., greenbriers; *Symphoricarpos orbi-*

culatus, coralberry; *Viburnum* spp., Viburnums; *Vitis* spp., wild grapes.

Herbaceous Plants.—*Andropogon furcatus*, big bluestem; *Andropogon scoparius*, little bluestem; *Andropogon virginicus*, broomsedge; *Chamaecrista* spp., partridge peas; *Helianthus* spp., wild sunflowers; *Lespedeza*, lespedeza; *Sorghastrum nutans*, Indian grass.

Uses of Marsh and Aquatic Species

	Silt-trainers	Bank-binders	Wave-breakers	Spring and spring slough species	Wildlife food
Acorus calamus (sweetflag)	....	x	....	....	x
Bacopa rotundifolia [1] (waterhyssop)	....	....	x	....	....
Carex spp. (sedges)	x	x	....	....	....
Cephalanthus occidentalis [2] (buttonbush)	x	....	....	x	x
Ceratophyllum demersum [3] (coontail)	....	....	x	....	....
Chara spp. (muskgrasses)	....	....	....	x	....
Cyperus spp. (Cyperus)	....	....	....	....	x
Cornus spp.[2] (dogwoods)	x	....	....	....	x
Dianthera americana (waterwillow)	....	....	....	x	....
Echinochloa crus-galli [1] (duck millet)	x	x	....	....	x
Eleocharis spp. (spikerush)	x	x	....	x	....
Hibiscus spp.[2] (swamp mallows)	x	....	....	....	x
Jussiaea diffusa (water primrose)	....	....	x	....	....
Leersia oryzoides [1] (rice cutgrass)	x	x	....	....	x
Myriophyllum spp.[3] (watermilfoil)	....	....	x	....	....
Potamogeton spp.[3] (pondweeds)	....	....	x	x	....
Polygonum spp.[1] (smartweeds)	x	....	....	....	x
Radicula nasturtium-aquaticum (watercress)	....	....	....	x	....
Sagittaria spp.[1] (arrowheads)	....	x	....	x	x
Sambucus canadensis [2] (elderberry)	x	....	....	....	x
Saururus cernuus (lizard's-tail)	....	....	....	x	....
Scirpus americanus (three-square)	....	x	....	....	....
Scirpus fluviatilis (river bulrush)	x	....	....	....	....
Scirpus occidentalis (soft-stemmed bulrush)	x	....	....	....	x
Sparganium spp. (burreeds)	x	x	....	....	....
Zizaniopsis miliacea (southern wild rice)	x	x	....	....	x

[1] Annuals.
[2] Shrubs.
[3] Valuable for waterfowl; not to be planted in fish ponds.

CASH IN THE RANCHER'S POCKET

(*Continued from page 226*)

A fifth point is that these ranches, where protection is given the range and where rigid control of hunting is practiced, are said to be the only lands within the State in which deer and turkey populations are not declining, although they are by no means the only territories adapted to these species. Several of the preserves where little or no management is practiced still have a good many deer, but the population is gradually being reduced. On many areas which could be made into good deer country, but are now open to free hunting, the deer and turkey populations have, for all practical purposes, disappeared.

There remain, however, some good deer and turkey-shooting areas on farms in Texas. A few ranchers, under the direction of the game commission, have set up preserves and charged enough for the privilege of hunting on them to make it profitable to maintain game populations. It is claimed that such commercialization of hunting deprives certain classes of people of the hunting privilege. But considering the steadily diminishing supply of game under the free hunting system, and the mounting costs involved in finding and bagging it, the validity of such a claim may be seriously questioned. The sportsman who cannot pay the price does not get even the "free" game; and each season the price reaches a new high because the game population drops to a new low.

Actually, free hunting passed with free land. It is now a delusion for which we pay a terrific toll in wildlife of all sorts. The State may own the game, but he who owns the land determines whether or not it shall live or die. The landowner may not kill out of season or exceed the bag limit, under penalty of the law. But he may, by destruction of habitat, wipe out at one stroke the entire wildlife population of his lands, and the State cannot lift a finger. Of course, no landowner would deliberately do such a thing, but thousands are doing it, little by little, either because they do not understand the needs of wildlife or because economic pressure drives them to wring some return from every acre.

Wildlife management is a practical art. General application of its principles would ensure the maintenance of reasonable wildlife population in perpetuity. But the most important management measure—the provision of adequate habitat—must be carried out on the land, and this involves trouble and oftentimes expense. If we can set in operation a system that will make it worth while for the landowner to practice wildlife management we can without question reverse the present downward trend in farm and ranch game. Is Texas pointing the way?

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